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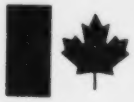

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DEPARTMENT OF THE ENVIRONMENT
ENVIRONMENTAL PROTECTION SERVICE
PACIFIC REGION

SHELLFISH GROWING WATER BACTERIOLOGICAL AND SANITARY SURVEY OF NANOOSE HARBOUR, LASQUETI ISLAND, DEEP BAY AND PIPERS LAGOON, BRITISH COLUMBIA 1983-1984

Regional Program Report: 84-22

By

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ABSTRACT

During May and June 1983 and February and March 1984, the Environmental Protection Service conducted bacteriological surveys of bivalve molluscan shellfish growing waters in Nanoose Harbour, Lasqueti Island, Deep Bay and Pipers Lagoon. The surveys were conducted to classify the shellfish growing waters in accordance with federal bacteriological pollution standards for acceptable shellfish harvesting areas. Sanitary surveys were done concurrently to identify and evaluate the sources of fecal pollution to the marine waters.

The data collected indicated that the majority of shellfish growing areas met the approved bacteriological standard. However, portions of Pipers Lagoon, Lantzville and Deep Bay are subject to levels of fecal contamination which render the waters unsuitable for shellfish harvesting all or part of the time. As a result the present closures in Deep Bay and Lantzville will be retained, and Pipers Lagoon will be closed under Schedule I of the Pacific Shellfish Regulations.

RÉSUMÉ

Durant les mois de mai et de juin 1983, puis de février et mars 1984, le Service de la protection de l'environnement a conduit des études bactériologiques des eaux où vivent des mollusques bivalves dans les régions suivantes: Nanoose Harbour, Lasqueti Island, Deep Bay et Pipers Lagoon. Les études ont eu pour objet de classifier les eaux où vivent les mollusques pour déterminer les régions acceptables pour leur récolte, par rapport aux normes fédérales de pollution bactériologique. En même temps, des études sanitaires ont eté conduites pour identifier et évaluer les sources de pollution fécale des eaux marines.

Les résultats obtenus ont révélé que la majorité des zones où vivent les mollusques étaient conformes à la norme bactériologique approuvée. Cependant, certaines parties de Pipers Lagoon, Lantzville et Deep Bay ont atteint des niveaux de contamination fécale tel que leurs eaux soient impropres à la récolte des mollusques, de façon continue ou discontinue. En raison de ces résultats, les présentes fer,etires serpmt maintenue pour Deep Bay et Lantzville tandis que Pipers Lagoon sera fermé en vertu de la partie I des règlements sur les mollusques bivalves du Pacifique.

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LIST OF ABBREVIATIONS

DFO	Department of Fisheries and Oceans
EPS	Environmental Protection Service
FC	Fecal coliform
FS	Fecal streptococci
m	metres
mL	millilitres
m^3/sec	cubic metres per second
MF	Membrane Filtration
MPN	Most Probable Number
ppt	parts per thousand

CONCLUSIONS

1. Water quality in Deep Bay did not meet the approved shellfish water quality fecal coliform standard. Data interpretation suggests non-point pollution to be the cause. Fecal coliform levels were generally higher during the winter survey, possibly due to sewage discharges from herring vessels moored at the government dock and anchored in the bay. Alteration of the existing shellfish closure is not recommended.

2. Nanoose Harbour growing waters met the approved shellfish growing water fecal coliform standard. Elevated levels of fecal coliforms were found at the head of the harbour, possibly due to the large number of waterfowl that inhabit the area. A pasture area at the northwest corner of the estuary may cause sporadic contamination of the tide flats under certain rainfall, tide and water table conditions. This was not documented during these surveys.

3. Lantzville water quality met the approved shellfish growing water fecal coliform standard, with the exception of one station. However, pollution sources identified during previous surveys have not been removed and historical water quality data remain valid. Consequently, alteration of the shellfish closure is not recommended.

4. Pipers Lagoon showed fecal contamination exceeding the shellfish growing water standard during both surveys. The only identified source of fecal contamination was the waterfowl which frequently feed in the area. A further potential sewage source was the sewage pump station at Pipers Lagoon. However, the station is telemetered and no failures resulting in overflows have been reported.

5. Hammond Bay showed some sporadic contamination, with one station not meeting the shellfish growing water standard. The source of contamination was not determined.

6. The shellfish growing waters around Lasqueti Island met the approved shellfish growing water fecal coliform standard with the exception of two stations. The source of contamination was not determined, and further survey work will be necessary to determine the pollution sources.

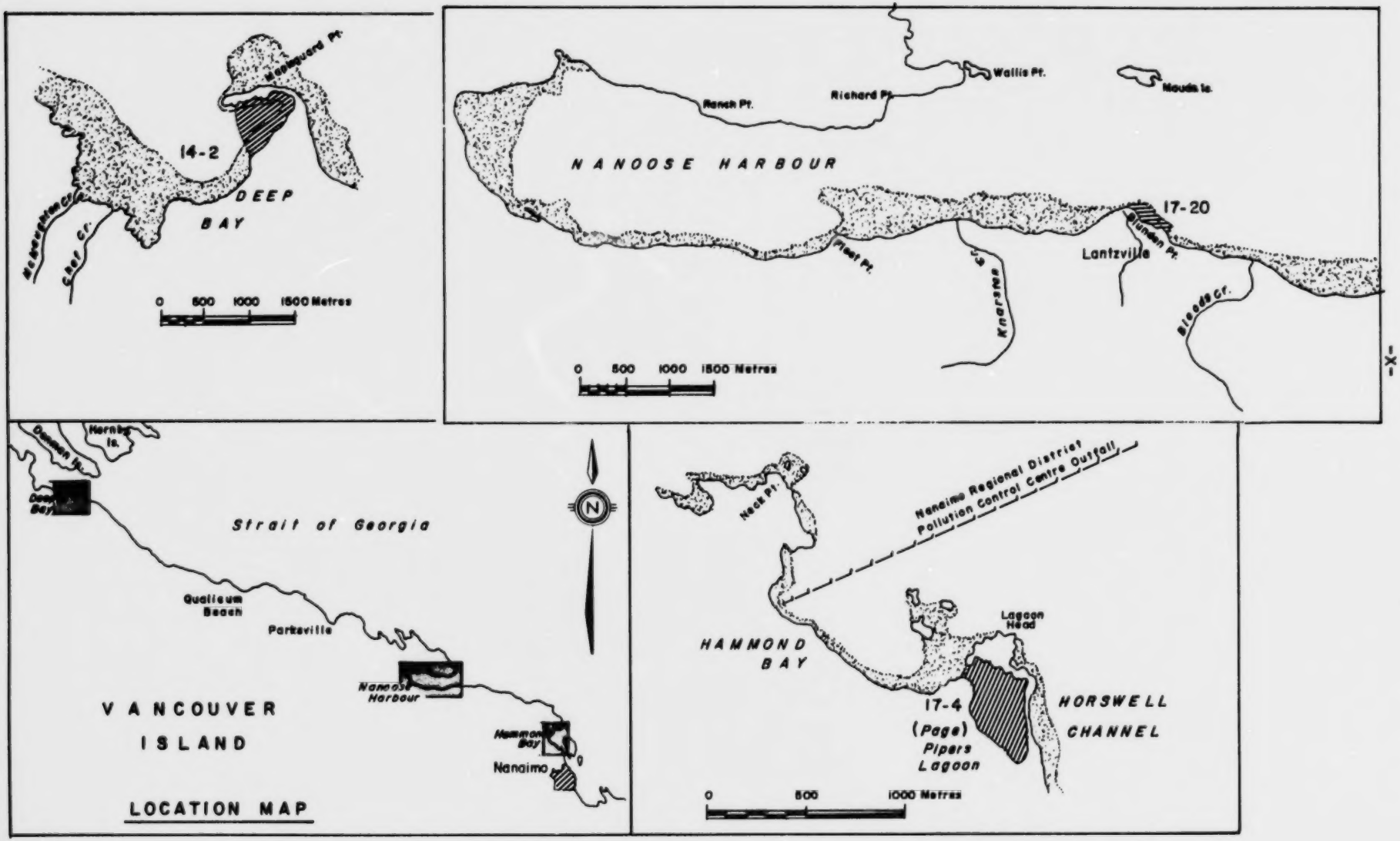

FIGURE I SCHEDULE I SHELLFISH CLOSURES IN STUDY AREA

SCHEDULE I CLOSURES

The following addition to Schedule I (Contaminated Areas) of the Pacific Shellfish Regulations has been recommended to the Pacific Shellfish Standing Committee.

Addition

1. Area 17-4. The waters and tidal foreshore of Pipers (Page) Lagoon, Area 17, lying inside, that is southeasterly of, a line drawn across the narrow entrance of the lagoon.

Retained

1. Area 17-20. The tidal foreshore of Lantzville from Peterson Road eastward to a point 50 m east of the boat ramp at Shoregrove Resort.

2. Area 14-2. The waters and tidal foreshore of Deep Bay, Baynes Sound lying within 300 m of the government wharf.

1. INTRODUCTION

The study area discussed in this report includes Deep Bay, Nanoose Harbour, Lantzville, Hammond Bay-Pipers Lagoon and Lasqueti Island. Twelve commercial oyster leases are presently listed with the Marine Resources Branch as being active in Nanoose Harbour and Lasqueti Island. Nanoose Harbour also has an active provincial recreational oyster reserve.

Previous shellfish water quality studies were carried out by the Environmental Protection Service in Deep Bay (1), Nanoose Harbour-Lantzville (2), Pipers Lagoon (2)(3) and Lasqueti Island (4).

Deep Bay was assessed in 1974 (1) and had acceptable water quality for the harvesting of shellfish, but was closed due to the potential pollution from summer homes and increased boating activity during the summer months. A study of Nanoose Harbour-Lantzville in 1977(2) showed acceptable water quality in Nanoose Harbour, however contamination of the Lantzville foreshore resulted in a Schedule I closure which is still in effect. Pipers (Page) Lagoon was previously studied in 1977(2) and 1978(3). The study in 1977 included Hammond Bay and at that time all stations met the shellfish growing water standard. The study in 1978 also demonstrated the lagoon's acceptable water quality. The Lasqueti Island study of in 1974(4) indicated acceptable quality at all stations.

A re-assessment of the shellfish growing water classifications in the study areas was deemed necessary: (i) to evaluate the increased utilization of tidal and subtidal areas for commercial oyster culture and clam harvesting; (ii) to investigate the increasing incidence of contaminated commercial shellfish product reportedly harvested from approved growing areas; (iii) to determine the adequacy of existing shellfish closures; and (iv) to ensure compliance with the Canadian Shellfish Safety Program, which requires a full re-assessment of commercial shellfish areas every ten years.

Bacteriological and sanitary surveys were carried out between May 31 and June 9, 1983 and February 27 and March 7, 1984, to coincide with different pollution conditions (i.e. dry period versus wet period).

2. SAMPLE STATION LOCATIONS

Marine sample stations were located in commercially harvested oyster and clam areas, including provincially registered oyster leases. Resource information was obtained from the Department of Fisheries and Oceans and the Marine Resources Branch.

All major freshwater inputs to the study areas were sampled to determine the significance of their bacterial contributions to the receiving waters.

Further fecal coliform testing was conducted on effluents, and dye tests were performed to determine their impact on the foreshore.

Samples of sediment and shellstock were periodically collected as an adjunct to the water sampling program.

3. FIELD PROCEDURES AND METHODS

3.1 Bacteriological Sampling and Analyses

All marine water samples for bacteriological analyses were collected in sterile wide-mouth glass bottles, approximately 15-30 cm below the water surface. The water depth at collection points over shellfish beds did not usually exceed 1.5 m. Samples were stored in coolers at temperatures not exceeding 10°C until processed. All analyses were conducted on site in the EPS mobile microbiology laboratory, generally within five hours of collection.

The fecal coliform MPN per 100 mL was determined using the multiple tube fermentation technique (three decimal dilutions of five tubes each) as described in Part 908 of the 15th edition of Standard Methods for the Examination of Water and Wastewater (5). The culture medium used was the A-1 medium as described by Andrews and Presnell (6) and further evaluated by Kay (7). A-1 medium was prepared in this laboratory.

All freshwater samples were collected in sterile wide mouth glass bottles and were tested for fecal coliform and fecal streptococci using the membrane filtration method described in Part 909 and 910 of the 15th edition of Standard Methods. Media used were mFC and KF Streptococcus Agars obtained from Difco laboratories, Detroit, for the fecal coliform and fecal streptococi tests respectively. The membrane filters used were Millipore HA, obtained from Millipore Limited, Mississauga, Ontario.

Biochemical confirmation of fecal coliform isolates obtained from the MPN procedure was performed on a percentage of all samples collected. These results are presented in Appendix VI.

3.2 Physical Testing Analyses and Equipment

Salinity measurements were made on all marine samples using an American Optical Refractometer (Catalogue No. 10413) which has a resolution to the nearest 0.5 ppt.

4. RESULTS AND DISCUSSION

The daily data record for marine sample stations, including salinity, fecal coliform MPN/100 mL, time of collection and state of tide, is presented in Appendix I. Bacteriological results for freshwater stations are summarized in Appendix IV. Freshwater sample station descriptions are given in Appendix II and daily freshwater bacteriological data is summarized in Appendix III.

Canadian bivalve molluscan shellfish growing waters are classified according to the following bacteriological criteria:

> In order that an area be considered bacteriologially safe for the harvesting of shellfish, the fecal coliform median MPN of the water must not exceed 14 per 100 mL, and not more than 10% of the samples ordinarily exceed an MPN of 43 per 100 mL, in those portions of area most probably exposed to fecal contamination during the most unfavorable hydrographic and pollution conditions.*

Based on these criteria, 10 of the 56 sample stations did not meet the approved growing water standard during some or all of the sampling periods. These data are discussed in detail later.

Shellfish growing areas can also be closed on the basis of known or potential pollution sources which may or may not be reflected in the bacteriological water quality results. All major freshwater inputs to the study areas were therefore sampled and both fecal coliform and fecal streptococci measurements were performed on these samples. The fecal coliform:fecal streptococci ratio (FC:FS) of each input was calculated where both mean values exceeded 100/100 mL in an attempt to determine the origin of fecal contamination observed. Geldreich and Kenner (8) have reported higher FS than FC levels in all warm-blooded animal feces except for humans. The ratio (FC:FS) in humans was 4.4 whereas in other warm-blooded animals the ratio was less than 0.7.

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*This report expresses the 10% limit in terms of a 90 percentile which must not exceed 43/100 mL.

Care must be taken in the interpretation of FC:FS data and in this report they are presented as supporting data for sanitary investigations. The calculated FC:FS ratios are presented in Appendix IV.

Rainfall records were obtained from the Atmospheric Environment Service stations at Nanaimo and Texada Island and are presented in Appendix V. Rainfall did not have a significant effect on the water quality in the study areas.

4.1 Deep Bay (Marine Stations BS1-BS4)

The area was surveyed to determine the extent of fecal coliform pollution due to boating activity and its possible impact on a shellfish lease just north of Deep Bay and the recreational harvesting that may occur on the west bank.

A previous EPS survey in 1974 (1) established that the shellfish water quality of Deep Bay was acceptable. However, normal 125 m wharf closure was increased to 300 m to protect against the possible pollution effects of increased boating activity and summer home occupancy during summer months.

During the 1983 and 1984 surveys, contamination exceeding the approved shellfish growing water standard was evident as shown in Table 1 and Table 2.

TABLE 1 DATA SUMMARY - DEEP BAY - BASED ON MEDIAN AND 90 PERCENTILES

STATION	SPRING	WINTER	COMBINED
BS1	X	X	X
BS2		X	X
BS3			
BS4		X	

X = exceeds the shellfish growing water standard

TABLE 2 SUMMARY OF FECAL COLIFORM MPN DATA FOR MARINE SAMPLE STATIONS - DEEP BAY

SAMPLE STATION	MAY 31 - JUNE 9, 1983 (MPN/100 mL)				FEBRUARY 27 - MARCH 7, 1984 (MPN/100 mL)				ALL DATA (MPN/100 mL)			
	No. of Samples	Range	Median	90 Percentile	No. of Samples	Range	Median	90 Percentile	No. of Samples	Range	Median	90 Percentile
BS1	5	< 2 - 240	< 2	121.0	5	< 2 - 79	79.0	111.5	10	< 2 - 240	2.0	130.0
BS2	5	2 - 49	8.0	28.5	5	< 2 - >1600	13.0	816.5	10	< 2 - >1600	7.5	49.0
BS3	5	< 2 - 49	13.0	41.0	5	< 2 - 22	2.0	11.0	10	< 2 - 49	13.0	33.0
BS4	5	< 2 - 26	7.0	19.5	5	< 2 - 130	8.0	78.5	10	< 2 - 130	7.5	27.0

During the winter survey (Figure 2) the number of fishing vessels moored and anchored in Deep Bay exceeded 100 each day. Kay (9) has shown that increased boating activity can result in higher fecal coliform levels in embayed anchorage areas. The median and 90 percentile for the winter survey (all stations) was 7.5 and 130/100 mL MPN respectively. In the spring period the median was 7.5/100 mL MPN and the 90 percentile was 44.0/100 mL. The number of boats in the bay was less than 20 each day at this time.

Regression analysis indicated that there was some correlation between fecal coliform levels and same day 24 hour rainfall. Winter data gave the best correlation (r = 0.74) followed by combined data (r = 0.71) suggesting pollution may have resulted froma combination of land-based and vessel discharges. However, freshwater samples generally had low levels of fecal coliforms, with S2 having the highest results (0-242/100 mL FC). Significant non-point pollution was therefore not confirmed by the stream sampling.

Further testing was conducted in 1984 on shellstock samples BS1 and BS2, with fecal coliform counts of 80/100 g MPN being recorded in both samples.

4.2 Nanoose Harbour and Lantzville (NH1-NH54)

Nanoose Harbour has five oyster leases and one Provincial Shellfish Reserve (Figure 3). A previous survey (2) in 1977 determined that Nanoose Harbour water quality was acceptable while the Lantzville foreshore was not.

The sources of contamination identified during the 1977 survey in Lantzville included numerous freshwater streams, which were contaminated by fecal material from farm animals and domestic sewage, and two septic tank outfalls.

During the present surveys, only marine station NH45 exceeded the shellfish standard in 1983 (Table 3; Figure 4), and all stations met the shellfish standard in 1984. The source of contamination to NH45 was Blo 's Creek (S13) which had fecal coliform levels ranging between 200 and

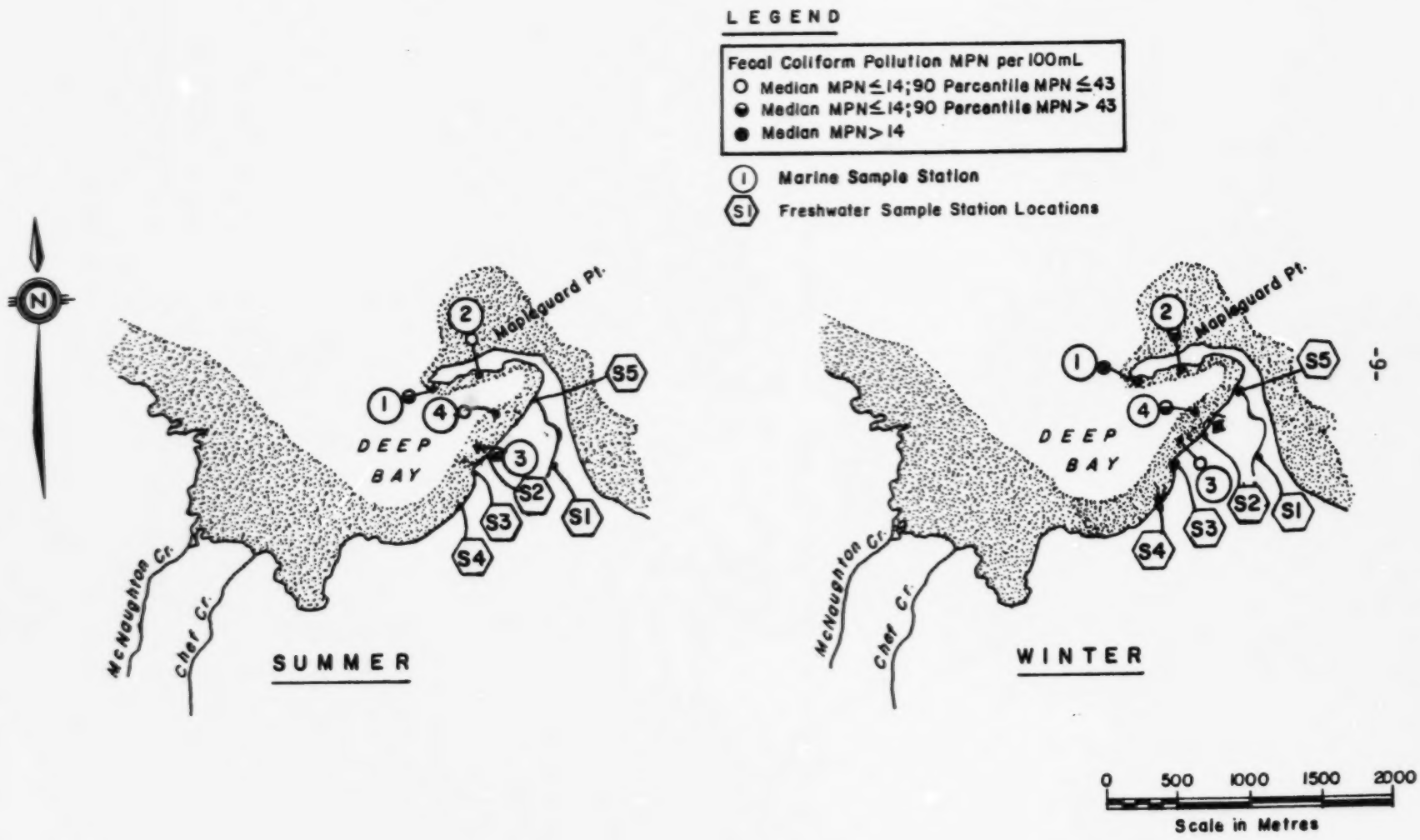

FIGURE 2 MARINE AND FRESHWATER SAMPLE STATION LOCATIONS - DEEP BAY

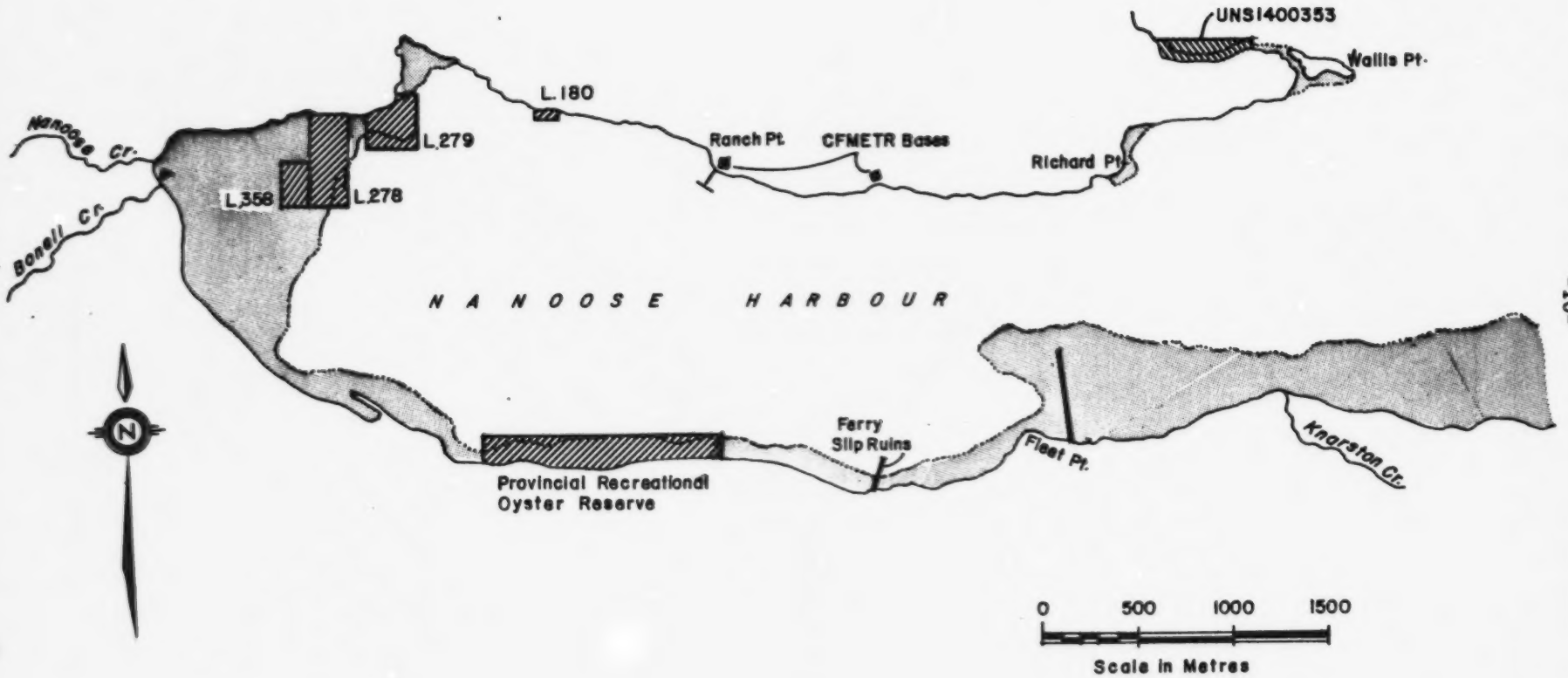

FIGURE 3 OYSTER LEASES - NANOOSE HARBOUR

TABLE 3 SUMMARY OF FECAL COLIFORM MPN DATA FOR MARINE SAMPLE STATIONS - NANOOSE HARBOUR, LANTZVILLE

SAMPLE STATION	MAY 31 - JUNE 9, 1983 (MPN/100 mL)				FEBRUARY 27 - MARCH 7, 1984 (MPN/100 mL)				ALL DATA (MPN/100 mL)			
	No. of Samples	Range	Median	90 Percentile	No. of Samples	Range	Median	90 Percentile	No. of Samples	Range	Median	90 Percentile
NH1	9	< 2 - 2	< 2	< 2	6	< 2 - 2	< 2	2.0	15	< 2 - 2	< 2	< 2
NH5	9	< 2 - 2	< 2	< 2	7	< 2 - 2	< 2	< 2	16	< 2 - 2	< 2	< 2
NH8	9	< 2 - 22	2	12.1	9	< 2 - 8	2.0	5.3	18	< 2 - 22	4.0	14.3
NH9	9	< 2 - 8	< 2	5.3	9	< 2 - 2	< 2	< 2	18	< 2 - 8	< 2	2.9
NH10	8	< 2 - 13	2.0	4.0	8	< 2 - 8	< 2	5.6	16	< 2 - 8	2.0	7.1
NH11	9	< 2 - 2	< 2	< 2	10	< 2 - 5	< 2	4.0	19	< 2 - 5	< 2	2.2
NH12	9	< 2 - 23	3.0	8.3	10	< 2 - 5	< 2	2.0	19	< 2 - 23	< 2	8.3
NH13	9	< 2 - 23	< 2	12.2	10	< 2 - 5	< 2	2.0	19	< 2 - 23	< 2	6.2
NH14	9	< 2 - 23	< 2	5.9	10	< 2 - 8	< 2	5.0	19	< 2 - 23	< 2	5.3
NH15	9	< 2 - 33	< 2	7.9	9	< 2 - 79	8.0	23.2	18	< 2 - 79	< 2	20.2
NH16	9	< 2 - 11	< 2	8.3	10	< 2 - 11	< 2	11.0	19	< 2 - 11	< 2	11.0
NH17	9	< 2 - 5	< 2	2.3	8	< 2 - 13	< 2	9.0	17	< 2 - 8	< 2	5.0
NH18	9	< 2	< 2	< 2	9	< 2 - 7	< 2	5.2	18	< 2 - 7	< 2	2.6
NH19	9	< 2 - 4	2.0	2.2	9	< 2 - 6	< 2	2.8	18	< 2 - 6	< 2	2.6
NH20	9	< 2 - 13	2.0	4.9	9	< 2 - 8	< 2	5.0	18	< 2 - 13	< 2	5.6
NH23	9	< 2	< 2	< 2	7	< 2 - 23	< 2	6.9	16	< 2 - 23	< 2	< 2
NH25	9	< 2 - 33	< 2	5.1	7	< 2 - 5	< 2	5.0	16	< 2 - 33	2.0	5.0
NH28	7	< 2 - 17	2.0	14.9	6	< 2 - 7	< 2	5.2	13	< 2 - 17	2.0	13.1
NH32	7	< 2 - 13	5.0	9.5	6	< 2 - 2	2.0	2.0	13	< 2 - 13	4.0	7.7
NH36	7	< 2 - 8	2.0	5.9	6	< 2 - 5	2.0	5.0	13	< 2 - 8	2.0	5.0
NH41	7	< 2 - 8	< 2	3.8	6	< 2 - 8	< 2	6.2	13	< 2 - 8	< 2	7.1
NH45	7	< 2 - 49	2.0	49.0	6	< 2 - 7	< 2	4.0	13	< 2 - 49	< 2	36.7
NH47	7	< 2 - 4	< 2	< 2	6	< 2 - 2	< 2	< 2	13	< 2 - 4	< 2	< 2
NH52	9	< 2 - 2	< 2	< 2	6	< 2 - 5	< 2	3.2	15	< 2 - 5	< 2	< 2
NH53	9	< 2 - 5	< 2	< 2	9	< 2 - 2	< 2	< 2	18	< 2 - 5	< 2	< 2
NH110					5	< 2 - 2	< 2	< 2				
NH530					5	< 2	< 2	< 2				
NH54					2	< 2						

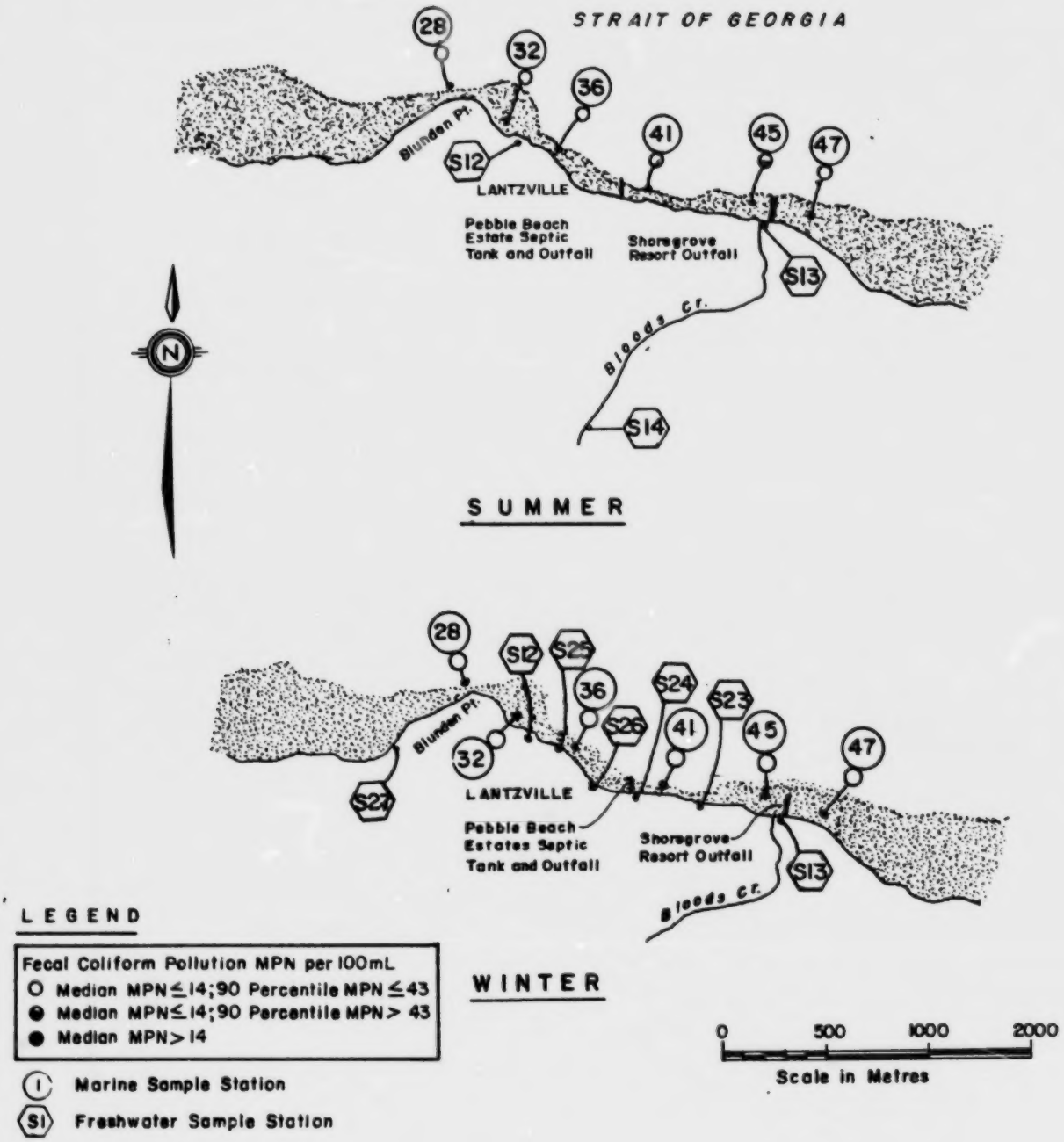

FIGURE 4 MARINE AND FRESHWATER SAMPLE STATION LOCATIONS - LANTZVILLE

1450/100 mL MF in 1983 (Appendix IV, Table 1). In 1984 the fecal coliform levels dropped to a range of 9-30/100 mL MF, which coincided with acceptable water quality at station NH45.

A possible source of contamination to Bloods Creek was identified as waterfowl kept by a residence at Warwick Road, where the creek has been dammed off to create small ponds for the birds. A freshwater sample (S14) taken upstream of the ponds had a fecal coliform level of 30/100 mL MF, while a sample (S13) taken downstream had a fecal coliform count of 200/100 mL MF. However, the mean FC:FS ratio for 1983 data of 3.51 indicates a possible human sewage source which could not be identified.

Bloods Creek and station LH45 are located immediately west of the Shoregrove Resort. The resort facilities are serviced by a total of 13 septic tanks which discharge unchlorinated effluent into a common outfall (Waste Management Branch permit PE-2626). The outfall discharges up to 16 m^3/day of effluent through a 91 m long outfall terminating at a depth of 3 m below low water.

A dye test of the outfall indicated that effluent did not surface and there were no visible leaks in the line.

Previous data (2) indicated some fecal contamination of the receiving waters in the vicinity of this outfall; however, the source was not conclusively identified.

The Lantzville Improvement District operates a small sewage collection system with a septic tank and marine outfall (PE-3633) near the foot of Lavender Road. The outfall is 114 m from the low water line and discharges 31.0 m^3/day of unchlorinated effluent. A dye test showed the retention time in the pipe to be about 2.5 hours and that the dye moved westerly to Blunden Point parallel to the Lantzville shoreline on a low slack tide. Four samples were collected at a depth of 0.3 meters in the dye path. The fecal coliform levels ranged from 5 to 8/100 mL MPN.

Previous survey work (2) indicated that septic tank treatment was hampered because sea water backed up through the outfall and into the septic tank at high tide. This situation was remedied by installing a back check valve and pump in 1978.

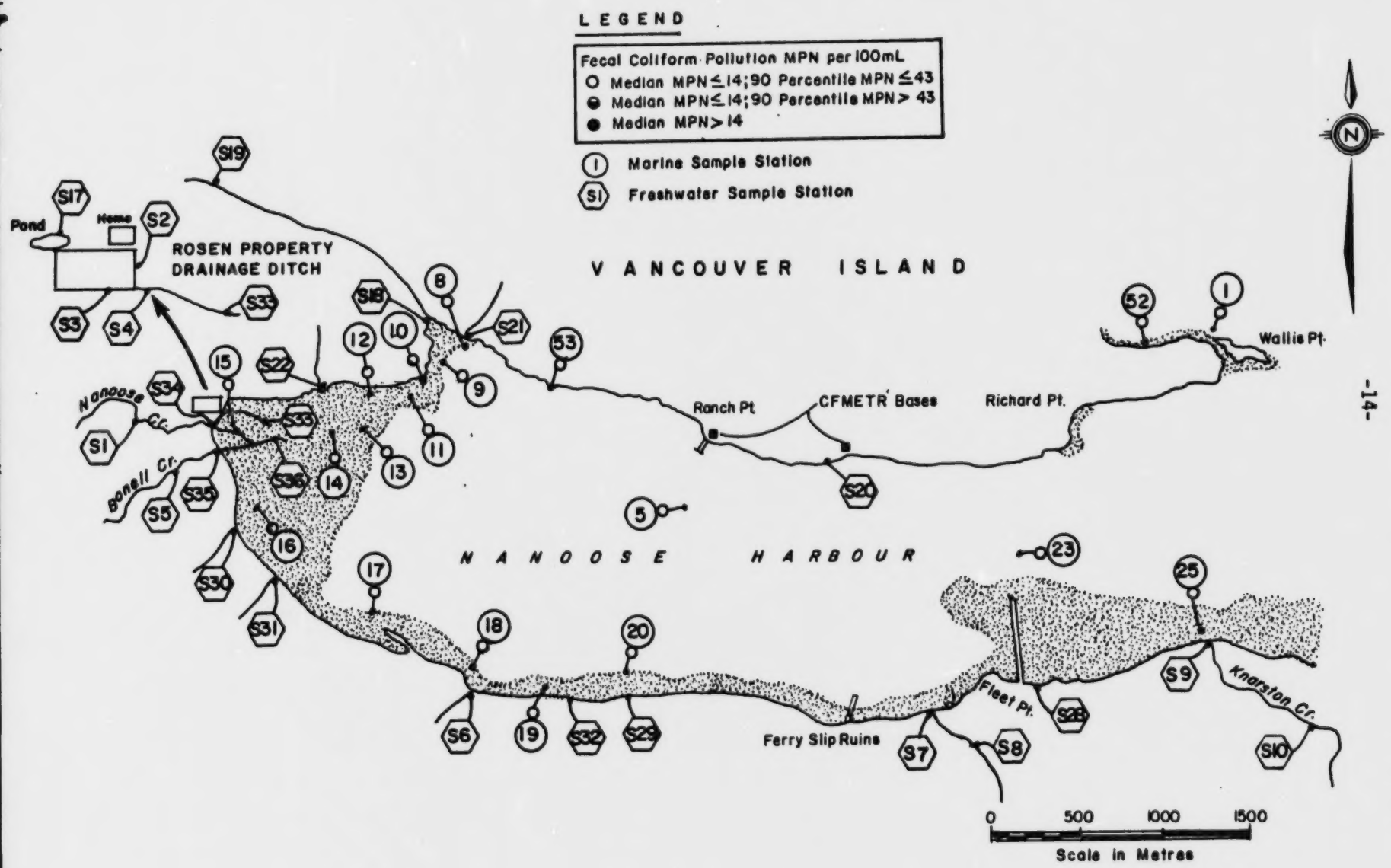

FIGURE 5 MARINE AND FRESHWATER SAMPLE STATION LOCATIONS - NANOOSE HARBOUR

In Nanoose Harbour all marine stations (Figure 5) met the shellfish water quality standard during both surveys (Table 3). Stations located in the estuarine area at the head of the harbour (NH12-NH16) showed elevated levels of fecal coliforms during the 1983 survey (Table 3). There are two major creeks entering the estuary, Nanoose Creek (S1) and Bonell Creek (S5). The fecal coliform levels were low in 1983 ranging from 10-187/100 mL MF for Nanoose Creek and 0-49/100 mL MF for Bonell Creek. Flow measurements of the creeks were not made and the mean population equivalents could not be determined. The highest fecal coliform levels in 1984 for either stream was 7/100 mL MF.

The levels of fecal coliforms may also be due to the waterfowl and gull populations which inhabit the Canadian Wildlife Service (CWS) bird sanctuary. According to the Canadian Wildlife Service (pers. comm. Neil Dawe, CWS Qualicum) the sanctuary is home to a few Canada geese, a small number of mallards and sea gulls especially during the herring roe season. CWS also reports numerous scaups, scoters and Western grebes in the harbour. A literature search (10, 11) indicates that waterfowl can contribute to fecal pollution of the marine environment.

Ditches (S2-S4) surrounding a grazing area for cows were sampled at a farm located at the head of the harbour. At the time of the surveys four cows were grazed at this pasture. The fecal coliform levels in 1983 were high at S2 and S4 (Appendix III, Table I) with ranges of 220-430 and 210-510/100 mL respectively. Subsequent sampling of the main drainage (S33) from the grazing area gave low fecal coliform result during February, and no impact was noted in the marine waters. During heavy rainfall periods, neap high tides, or high water table fecal contamination of the nearby oyster leases may be possible.

Two other facilities were investigated during the sanitary survey at the head of Nanoose Bay. The Pentecostal Church camp, located south of Bonell Creek is used extensively during the summer months and is serviced by a septic tank and tile field system. It was not known how frequently the tank is pumped out; however, the system appears to be far enough away from the foreshore to limit any impact on the marine environment.

The mobile home park west of the intersection of Ranch Point and Northwest Bay road is also serviced by septic tank and disposal field. No problems were found with the system.

North of Nanoose Harbour, the Fairwind Estates development has been granted an effluent discharge permit (PE-7214) to dispose of sewage on the north side of the Nanoose Peninsula at a point offshore of Schooner Cove.

On the north shore of Nanoose Harbour the Department of National Defence, has two shore stations supporting the Canadian Forces Maritime Experimental and Test Ranges (CFMETR). The two stations are individually connected to separate septic tank and tile field systems. Both systems were functioning properly during the two surveys. Each shore station has moorage facilities, but sewage discharges are not permitted from any moored vessel.

Oyster samples collected in 1983 at the head of Nanoose Harbour for bacteriological analyses had a fecal coliform count of less than 20/100 g MPN. In 1984 EPS collected oysters at the head of Nanoose Harbour in the vicinity of NH14 and NH15. Fecal coliform results were less than 20 and 50/100 g MPN respectively.

4.3 Hammond Bay - Pipers Lagoon

Previous survey work in these areas was conducted in 1977 and 1978. The survey in 1977(2) included Hammond Bay and Pipers Lagoon and found that all marine stations met the shellfish water quality standard.

Sewage from the residential areas around Hammond Bay and Pipers Lagoon receives primary treatment from the Nanaimo Regional District Pollution Control Center. The non-chlorinated effluent is discharged through a 2,030 m long outfall with diffuser at a depth of 76.2 metres. Chlorination of the effluent ceased on October 3, 1979.

The 1978 study (3) found that all marine stations in Pipers Lagoon met the shellfish growing water quality standard; Hammond Bay was not sampled at this time. The survey determined that a sewage pump station

TABLE 4 SUMMARY OF FECAL COLIFORM MPN DATA FOR MARINE SAMPLE STATIONS - PIPERS LAGOON

SAMPLE STATION	MAY 31 - JUNE, 1983 (MPN/100 mL)				FEBRUARY 27 - MARCH 7, 1984 (MPN/100 mL)				ALL DATA (MPN/100 mL)			
	No. of Samples	Range	Median	90 Percentile	No. of Samples	Range	Median	90 Percentile	No. of Samples	Range	Median	90 Percentile
PL59	6	2 - 430	11.0	219.4	5	2 - 79	13.0	51.0	11	2 - 430	13	79
PL60	5	2 - 540	11.0	309.5	5	< 2 - 49	5.0	41.0	10	< 2 - 540	17	79
PL62	4	2 - 110	22.5	83.2	5	2 - 49	13.0	31.5	9	< 2 - 49	10	43.6
PL64	1	5			5	< 2 - 79	4.0	64.0	6	< 2 - 79	4.5	61.0
PL65	1	5			5	< 2 - 7	2.0	6.0	6	< 2 - 7	3.5	5.8
PL66	1	4			4	< 2 - 46	6.5	30.8	5	< 2 - 46	5	27
PL67	1	17			5	< 2 - 33	11.0	23.5	6	< 2 - 33	12.5	23.4
PL68	1	23			5	< 2 - 31	8.0	24.0	6	< 2 - 31	12.5	26.2

at the intersection of Place Drive and Lagoon Road posed a threat to water quality. A dye test of the overflow from the station revealed that sewage could be discharged about 25 meters from shore. Subsequent to the 1978 survey the city of Nanaimo installed a telemetry system on the pump station and arrangements are now in place to notify the local fishery officer in the event of a sewage overflow. This pump station has other features that include high level alarm, power failure alarm and a stand-by generator set.

Surveys conducted in 1983 and 1984 showed unacceptable water quality during both seasons (Figure 6 and Table 4). This fecal contamination in Pipers Lagoon may be attributed to the waterfowl population which frequents the area. Geese and gulls have been shown to excrete fecal coliform levels in the magnitude of 10^7-10^8 fecal coliforms per day (10, 11). The other possible source of pollution, the pump station, did not malfunction during our survey periods.

In general the lagoon stations showed poorer water quality during the summertime and ebb tides (Table 5).

TABLE 5 SUMMARY OF PIPERS LAGOON STATIONS

TREATMENT	MEDIAN	90th PERCENTILE	CORRELATION WITH SAME DAY RAINFALL
All Summer Data	7.0	94.5	r = 0.84
All Winter Data	10.5	42.6	r = 0.74
All Data - Ebb Tide	14.0	334.0	
All Data - High Slack Tide	5	75.4	

Regression analysis (log MPN vs salinity [ppt]) for combined data from station 59, 60 and 62 showed a trend of higher MPNs with reduced salinities in the summer sampling ($r = -0.67$) but no significant correlation in winter sampling ($r = -0.03$).

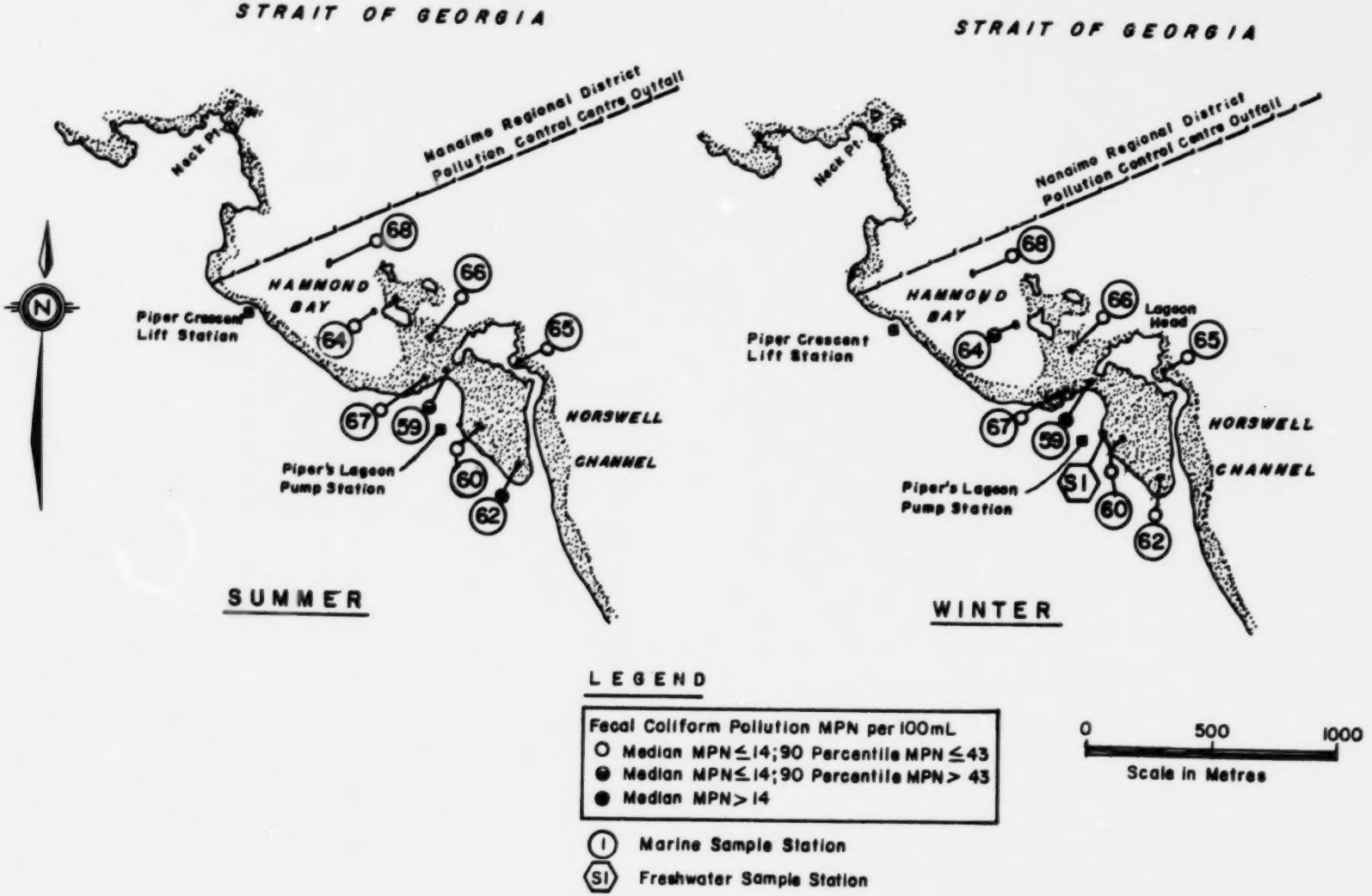

FIGURE 6 MARINE AND FRESHWATER SAMPLE STATION LOCATIONS - HAMMOND BAY AND PIPER'S LAGOON

Further regression analysis (log MPN vs same day precipitation) showed some correlation with elevated fecal coliform levels and same day rainfall for both sampling periods (Table 5). The correlation was more evident during the summer sampling period with a regression coefficient of 0.84.

Marine station PL59 was the only station to show continuous fecal contamination. This station was also sampled by the Hammond Bay Pollution Control Centre during May to October 1982. The results showed a fecal coliform range of less than 2/100 mL to 430/100 mL. The median and 90 percentile were 18.0 and 182.0/100 mL MPN respectively. Further data were collected by the Hammond Bay Pollution Control Centre in 1984. Station PL59 had a fecal coliform range of less than 2/100 mL to 36/100 mL for four samples. Station PL67 exceeded the shellfish standard with a median of less than 2/100 mL and a 90-percentile of 78.4/100 mL from seven samples.

Clam and sediment samples were only collected in 1983. The clam result was 5400/100 g MPN in the vicinity of PL60. The corresponding sediment had a count of < 20/100 g.

4.4 Lasqueti Island (LI1-LI18)

Lasqueti Island has 8 commercial oyster leases (Figure 7) and numerous areas for recreational shellfish harvesting. The area was last surveyed in 1974 (5), and at that time all marine stations except one met the shellfish growing water standard. The source of contamination was identified as droppings from the local sheep population.

Surveys conducted in 1983 and 1984 (Figure 8) found unacceptable water quality at station 11 during summer and station 17 in the winter (Table 6). However the median and 90 percentile were skewed by one or two high counts (Table 6).

Sources of contamination to the areas were not positively identified and further investigation will be conducted. Possible sources are the domestic animals or septic tank seepage.

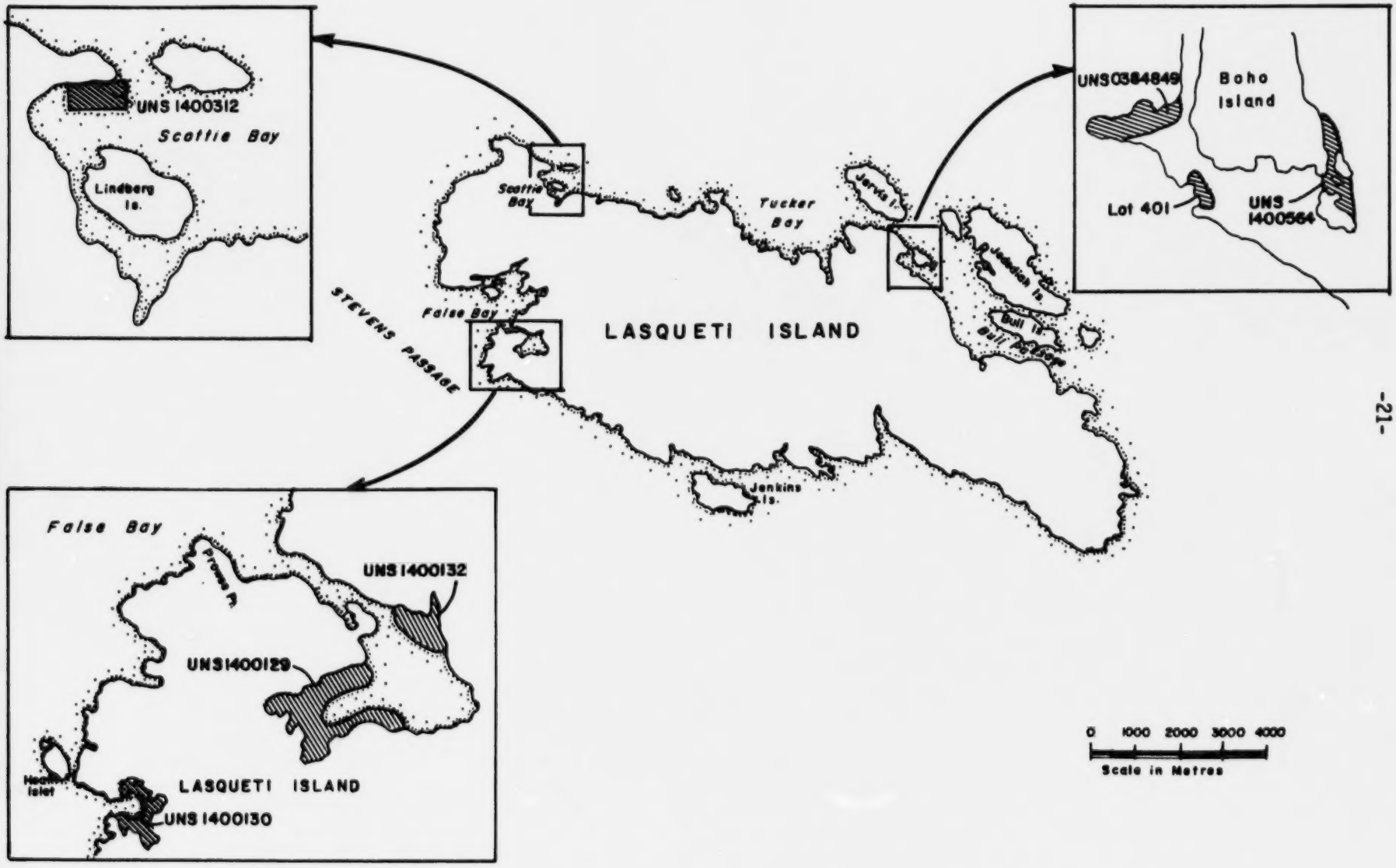

FIGURE 7 OYSTER LEASES - LASQUETI ISLAND

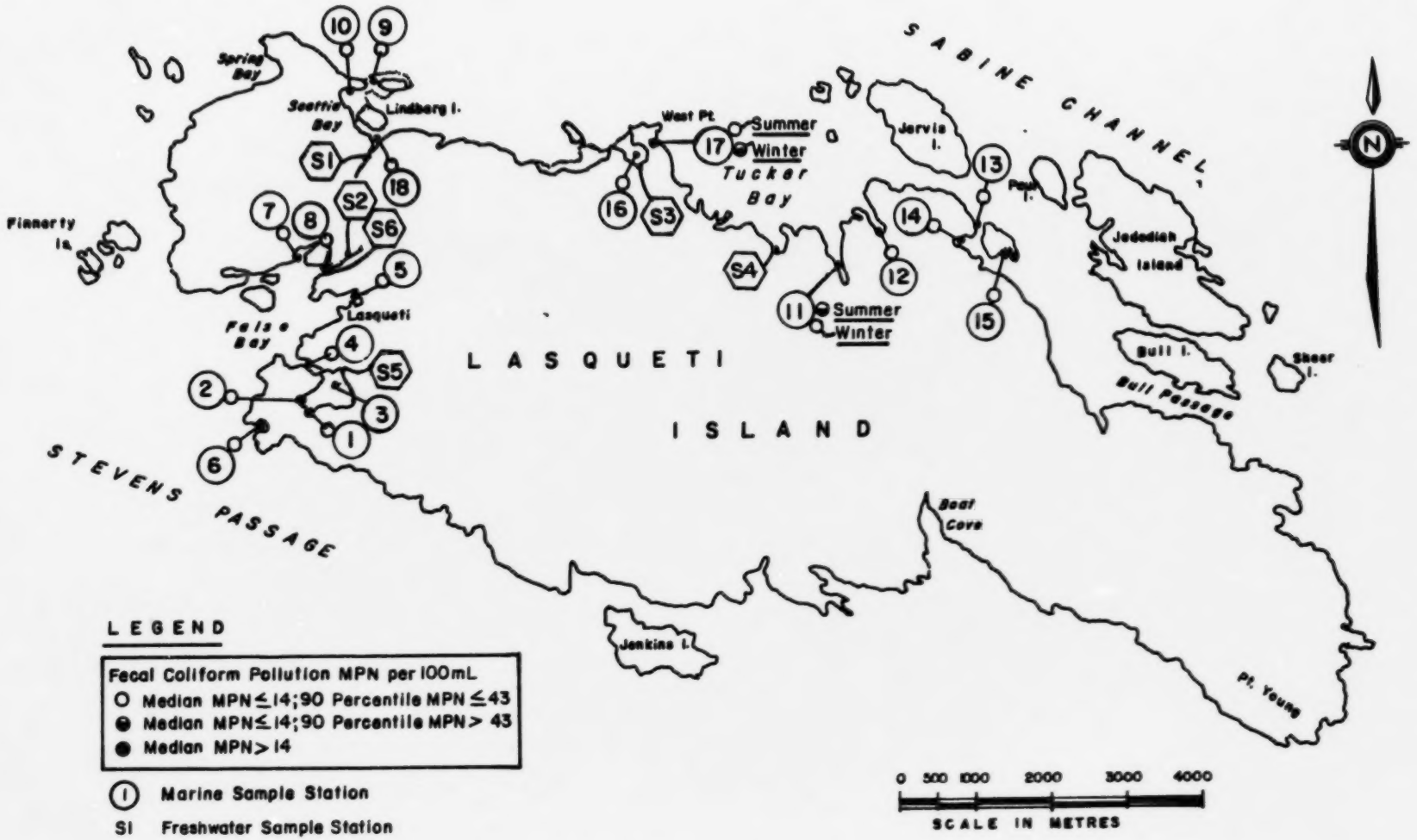

FIGURE 8 MARINE AND FRESHWATER SAMPLE STATION LOCATIONS - LASQUETI ISLAND

TABLE 6 SUMMARY OF FECAL COLIFORM MPN DATA FOR MARINE SAMPLE STATIONS - LASQUETI ISLAND

SAMPLE STATION	MAY 31 - JUNE 9, 1983 (MPN/100 mL)				FEBRUARY 27 - MARCH 7, 1984 (MPN/100 mL)				ALL DATA (MPN/100 mL)			
	No. of Samples	Range	Median	90 Percentile	No. of Samples	Range	Median	90 Percentile	No. of Samples	Range	Median	90 Percentile
LI1	7	< 2 - 11	5.0	8.2	5	< 2 - 4	< 2	2.0	12	< 2 - 11	3.0	5.0
LI2	7	< 2 - 13	< 2	5.3	5	< 2 - 2	< 2	< 2	12	< 2 - 13	< 2	2.0
LI3	7	< 2 - 5	2.0	4.3	5	< 2 - 11	2.0	6.5	12	< 2 - 11	< 2	4.8
LI4	7	< 2 - 2	< 2	< 2	5	< 2 - 17	< 2	8.5	12	< 2 - 17	< 2	< 2
LI5	6	< 2 - 9	3.0	8.4	5	< 2 - 4	2.0	3.0	11	< 2 - 9	2.0	7.6
LI6	7	< 2	< 2	< 2	5	< 2 - 2	< 2	2.0	12	< 2 - 2	< 2	< 2
LI7	6	< 2 - 11	2.0	5.6	5	< 2 - 23	< 2	12.5	11	< 2 - 23	2.0	10.1
LI8	6	< 2 - 2	< 2	< 2	5	< 2 - 2	< 2	< 2	11	< 2 - 2	< 2	2.0
LI9	7	< 2 - 2	< 2	< 2	5	< 2	< 2	< 2	12	< 2 - 2	< 2	< 2
LI10	7	< 2 - 2	< 2	< 2	5	< 2	< 2	< 2	12	< 2 - 2	< 2	< 2
LI11	7	2 - 130	11.0	50.9	4	< 2 - 2	< 2	< 2	11	< 2 - 130	8.0	16.7
LI12	7	< 2 - 5	< 2	2.9	4	< 2	< 2	< 2	11	< 2 - 5	< 2	2.0
LI13	7	< 2 - 2	< 2	< 2	4	< 2	< 2	< 2	11	< 2 - 2	< 2	< 2
LI14	7	< 2	< 2	< 2	4	< 2	< 2	< 2	11	< 2	< 2	< 2
LI15	7	< 2	< 2	< 2	4	< 2	< 2	< 2	11	< 2	< 2	< 2
LI16	6	< 2 - 17	2.0	9.8	4	< 2	< 2	< 2	10	< 2 - 17	< 2	5.0
LI17	6	< 2 - 7	2.0	4.0	4	< 2 - 540	110.0	412.0	10	< 2 - 540	< 2.0	220.0
LI18					5	< 2 - 3	2.0	8.0				

ACKNOWLEDGEMENTS

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APPENDIX I

DAILY DATA RECORD FOR MARINE STATIONS

APPENDIX
TABLE : Daily Data Record for Marine Sample Stations
(Area 14)

Station	Latitude	Longitude	Date	Time	Tide	Fec.Colif.	Salinity
BS001	49 27.90	124 44.05	83/05/31	1425	Low Slack	<2	20.0
			83/06/01	1345	Ebb	2	22.0
			83/06/04	1320	High Slack	<2	26.0
			83/06/06	1435	Flood	<2	25.5
			83/06/09	1400	Flood	240	26.0
			84/02/28	0915	Ebb	79	14.0
			84/02/29	1025	Low Slack	93	28.0
			84/03/01	1120	Low Slack	130	28.5
			84/03/02	1255	Low Slack	2	23.0
			84/03/05	1525	Flood	2	24.0
BS002	49 27.95	124 43.70	83/05/31	1420	Low Slack	8	19.5
			83/06/01	1345	Ebb	2	21.5
			83/06/04	1330	High Slack	2	26.0
			83/06/06	1440	Flood	8	25.5
			83/06/09	1400	High Slack	49	26.0
			84/02/28	0910	Ebb	>1600	25.0
			84/02/29	1020	Low Slack	33	27.5
			84/02/29	1500	Low Slack	80	
			84/03/01	1115	Low Slack	7	28.5
			84/03/02	1300	Low Slack	13	22.5
			84/03/05	1535	Flood	<2	24.5
BS003	49 27.75	124 43.70	83/05/31	1410	Low Slack	33	19.0
			83/06/01	1335	Ebb	49	22.0
			83/06/04	1345	Ebb	<2	25.5
			83/06/06	1450	High Slack	13	25.5
			83/06/09	1450	Flood	13	26.5
			84/02/28	0935	Ebb	17	24.0
			84/02/29	1120	Low Slack	22	23.0
			84/03/01	1045	Low Slack	5	28.0
			84/03/02	1220	Low Slack	<2	18.5
			84/03/05	1545	Flood	<2	24.0
BS004	49 27.60	124 44.89	83/05/31	1405	Ebb	13	18.0
			83/06/01	1330	Ebb	<2	21.0
			83/06/04	1340	High Slack	<2	25.0
			83/06/06	1455	High Slack	7	25.5
			83/06/09	1400	Flood	26	26.5
			84/02/28	0925	Ebb	170	24.0
			84/02/29	1040	Low Slack	8	28.0
			84/03/01	1040	Low Slack	27	29.0
			84/03/02	1215	Low Slack	5	17.0
			84/03/05	1550	Flood	<2	23.5

APPENDIX I
TABLE 2 : Daily Data Record for Marine Sample Stations
(Area 17)

Station	Latitude	Longitude	Date	Time	Tide	Fec.Colif.	Salinity
NH001	49 16.33	124 06.50	83/05/31	1005	Ebb	2	27.0
			83/06/01	0940	Ebb	<2	26.0
			83/06/02	1555	Low Slack	<2	26.0
			83/06/03	1410	Ebb	<2	25.0
			83/06/04	1355	Ebb	<2	26.0
			83/06/05	1345	High Slack	<2	26.5
			83/06/06	1410	Flood	<2	26.0
			83/06/07	1415	Flood	<2	20.0
			83/06/08	1340	Flood	<2	20.5
			84/02/29	1015	Low Slack	<2	28.0
			84/03/02	0955	Ebb	<2	28.0
			84/03/03	0940	Ebb	<2	27.5
			84/03/04	0940	Ebb	2	26.5
			84/03/05	1100	Ebb	2	28.5
			84/03/06	1120	Ebb	<2	28.0
NH005	49 15.90	124 09.05	83/05/31	0935	Ebb	<2	26.5
			83/06/01	0925	High Slack	2	26.0
			83/06/02	1600	Low Slack	<2	26.0
			83/06/03	1425	Ebb	<2	25.0
			83/06/04	1435	Ebb	<2	25.5
			83/06/05	1435	High Slack	<2	26.0
			83/06/06	1500	High Slack	<2	25.0
			83/06/07	1450	Flood	<2	24.0
			83/06/08	1420	Flood	<2	20.0
			84/02/28	1030	Low Slack	<2	27.5
			84/02/29	0920	Ebb	<2	25.0
			84/03/02	0920	Ebb	<2	26.0
			84/03/03	0910	Ebb	<2	27.5
			84/03/04	0905	Ebb	2	27.5
			84/03/05	0950	Ebb	<2	28.0
			84/03/06	1015	Ebb	<2	26.5
NH008	49 16.31	124 10.15	83/05/31	0910	Ebb	<2	28.0
			83/06/01	0905	High Slack	2	27.0
			83/06/02	1635	Low Slack	<2	26.5
			83/06/03	1450	Ebb	<2	25.0
			83/06/04	1505	Ebb	<2	26.0
			83/06/05	1505	High Slack	5	26.0
			83/06/06	1525	High Slack	11	25.0
			83/06/07	1520	Flood	22	27.5
			83/06/08	1445	Flood	8	20.0
			84/02/28	1105	Low Slack	5	20.0
			84/02/29	0840	Ebb	2	25.0
			84/03/02	0900	Ebb	2	25.0
			84/03/03	0850	Ebb	4	25.5
			84/03/03	1540	Flood	<2	26.0
			84/03/04	0855	Ebb	5	27.5

APPENDIX I
TABLE 2: Daily Data Record for Marine Sample Stations
(Area 17)

Station	Latitude	Longitude	Date	Time	Tide	Fec.Colif.	Salinity
NH008	continued...		84/03/04	1605	Flood	<2	26.0
			84/03/05	1000	Ebb	<2	28.0
			84/03/06	1025	Ebb	8	6.5
NH009	49 16.30	124 10.22	83/05/31	0910	Ebb	<2	27.0
			83/06/01	0905	High Slack	<2	26.0
			83/06/02	1635	Low Slack	<2	26.5
			83/06/03	1445	Ebb	<2	25.0
			83/06/04	1500	Ebb	<2	26.0
			83/06/05	1500	High Slack	<2	26.0
			83/06/06	1515	High Slack	5	25.0
			83/06/07	1515	Flood	<2	27.0
			83/06/08	1440	Flood	8	20.5
			84/02/02	0855	Ebb	<2	
			84/02/28	1100	Low Slack	2	21.0
			84/02/28	1500	Low Slack	20	
			84/02/29	0840	Ebb	2	25.0
			84/03/02	0855	Ebb		25.0
			84/03/03	0850	Ebb	<2	27.5
			84/03/03	1530	Flood	<2	26.5
			84/03/04	0855	Ebb	<2	28.0
			84/03/04	1605	Flood	2	27.0
			84/03/05	1005	Ebb	<2	27.5
			84/03/06	1030	Ebb	<2	20.0
NH010	49 16.20	124 10.38	83/05/31	0905	Ebb	8	28.0
			83/06/01	0905	High Slack	2	26.0
			83/06/03	1445	Ebb	<2	25.0
			83/06/04	1500	Ebb	<2	25.5
			83/06/05	1500	High Slack	<2	26.0
			83/06/06	1515	High Slack	2	25.0
			83/06/07	1515	Flood	13	25.5
			83/06/08	1440	Flood	2	20.0
			84/02/28	1100	Low Slack	5	22.0
			84/02/29	0840	Ebb	8	22.0
			84/03/02	0855	Ebb	<2	22.0
			84/03/03	0850	Ebb	<2	27.5
			84/03/03	1530	Flood	<2	27.0
			84/03/04	1600	Flood	<2	27.0
			84/03/05	1010	Ebb	<2	28.0
			84/03/06	1030	Ebb	<2	23.5
NH011	49 16.14	124 10.45	83/05/31	0905	High Slack	2	27.5
			83/06/01	0900	High Slack	<2	26.5
			83/06/02	1630	Low Slack	<2	26.0
			83/06/03	1440	Ebb	<2	24.5
			83/06/04	1500	Ebb	<2	25.5

APPENDIX I
TABLE 2 : Daily Data Record for Marine Sample Stations
(Area 17)

Station	Latitude	Longitude	Date	Time	Tide	Fec.Colif.	Salinity	
NH011	continued...		83/06/05	1500	High Slack	<2	26.0	
			83/06/06	1520	High Slack	<2	25.0	
			83/06/07	1515	Flood	<2	26.0	
			83/06/08	1440	Flood	2	20.0	
			84/02/28	1055	Low Slack	4	22.0	
			84/02/29	0835	Ebb	5	22.0	
			84/03/02	0850	Ebb	<2	22.0	
			84/03/02	0850	Ebb	<2	28.0	*
			84/03/03	0845	Ebb	<2	27.0	
			84/03/03	0845	Ebb	<2	28.0	*
			84/03/03	1520	Flood	<2	27.0	
			84/03/03	1520	Flood	<2	27.5	*
			84/03/04	0845	Ebb	2	27.0	
			84/03/04	0845	Ebb	2	28.0	*
			84/03/04	1555	Flood	<2	27.5	*
			84/03/04	1600	Flood	<2	26.5	
			84/03/05	1015	Ebb	<2	27.5	
			84/03/05	1530	Flood	<2	27.5	
			84/03/06	1035	Ebb	<2	19.0	
NH012	49 16.18	124 10.60	83/05/31	0905	Ebb	5	26.0	
			83/06/01	0900	High Slack	11	26.0	
			83/06/02	1625	Low Slack	<2	26.0	
			83/06/03	1440	Ebb	<2	25.0	
			83/06/04	1500	Ebb	2	26.0	
			83/06/05	1455	High Slack	8	25.0	
			83/06/06	1510	High Slack	5	26.0	
			83/06/07	1510	Flood	<2	26.0	
			83/06/08	1435	Flood	23	20.0	
			84/02/28	1055	Low Slack	2	20.0	
			84/02/29	0835	Ebb	5	22.0	
			84/03/02	0845	Ebb	<2	22.0	
			84/03/03	0840	Ebb	<2	28.0	
			84/03/03	1520	Flood	2	27.0	
			84/03/04	0845	Ebb	<2	28.0	
			84/03/04	1555	Flood	<2	26.0	
			84/03/05	1010	Ebb	<2	28.0	
			84/03/05	1525	Flood	<2	27.5	
			84/03/06	1035	Ebb	<2	26.0	
NH013	49 16.04	124 10.64	83/05/31	0900	Ebb	<2	27.0	
			83/06/01	0900	High Slack	23	27.0	
			83/06/02	1620	Low Slack	<2	26.5	
			83/06/03	1435	Ebb	5	25.0	
			83/06/04	1455	Ebb	5	25.0	
			83/06/05	1455	High Slack	<2	25.0	
			83/06/06	1510	High Slack	<2	25.0	

APPENDIX I
TABLE 2 : Daily Data Record for Marine Sample Stations
(Area 17)

Station	Latitude	Longitude	Date	Time	Tide	Fec.Colif.	Salinity
NH013	continued...		83/06/07	1500	Flood	<2	26.0
			83/06/08	1500	Flood	11	20.0
			84/02/28	1055	Low Slack	5	21.0
			84/02/29	0830	Ebb	2	16.0
			84/03/03	0840	Ebb	2	26.0
			84/03/03	1515	Flood	<2	22.0
			84/03/04	0840	Ebb	<2	28.0
			84/03/04	1555	Flood	<2	26.5
			84/03/05	1015	Ebb	<2	28.0
			84/03/05	1525	Flood	<2	27.0
			84/03/06	1035	Ebb	<2	25.5
NH014	49 16.03	124 10.75	83/05/31	0855	Ebb	4	27.0
			83/06/01	0855	High Slack	23	27.0
			83/06/04	1455	Ebb	<2	26.0
			83/06/05	1455	High Slack	<2	25.0
			83/06/06	1510	High Slack	<2	25.0
			83/06/07	1510	Flood	<2	26.0
			83/06/08	1435	Flood	2	20.0
			84/02/28	1050	Low Slack	<2	21.5
			84/02/28	1500	Low Slack	<20	
			84/02/29	0830	Ebb	5	15.0
			84/03/02	0840	Ebb	<2	15.0
			84/03/03	0835	Ebb	2	24.5
			84/03/03	1515	Flood	<2	26.0
			84/03/04	0840	Ebb	<2	26.0
			84/03/04	1555	Flood	<2	26.5
			84/03/05	1015	Ebb	<2	26.0
			84/03/05	1520	Flood	<2	26.0
			84/03/06	1040	Ebb	8	19.0
NH015	49 16.04	124 11.31	83/05/31	0855	Ebb	33	26.0
			83/06/01	0855	High Slack	4	27.0
			83/06/02	0900	High Slack	<2	25.0
			83/06/03	1435	Ebb	5	25.0
			83/06/04	1450	Ebb	<2	26.0
			83/06/05	1455	High Slack	2	25.0
			83/06/06	1510	High Slack	<2	25.0
			83/06/07	1500	Flood	<2	26.5
			83/06/08	1435	Flood	<2	20.0
			84/02/28	1500	Flood	50	
			84/02/29	0830	Ebb	17	2.0
			84/03/02	0835	Ebb	2	
			84/03/03	0835	Ebb	13	23.5
			84/03/03	1515	Flood	79	16.0
			84/03/04	0830	Ebb	5	10.0
			84/03/04	1550	Flood	8	20.0

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TABLE 2 : Daily Data Record for Marine Sample Stations
(Area 17)

Station	Latitude	Longitude	Date	Time	Tide	Fec.Colif.	Salinity
NH015	continued...		84/03/05	1020	Ebb	8	26.0
			84/03/05	1520	Flood	<2	22.5
			84/03/06	1040	Ebb	2	25.0
NH016	49 15.81	124 11.28	83/05/31	0900	Ebb	11	26.0
			83/06/01	0855	High Slack	8	27.0
			83/06/02	0905	High Slack	2	25.5
			83/06/03	1435	Ebb	<2	25.0
			83/06/04	1450	Ebb	<2	26.0
			83/06/05	1450	High Slack	<2	25.0
			83/06/06	1510	High Slack	<2	25.5
			83/06/07	1505	Flood	<2	26.0
			83/06/08	1430	Flood	<2	20.0
			84/02/28	1045	Low Slack	12	10.0
			84/02/29	0820	Ebb	4	22.0
			84/03/02	0830	Ebb	<2	22.0
			84/03/03	0830	Ebb	<2	26.0
			84/03/03	1510	Flood	<2	24.0
			84/03/04	0830	Ebb	<2	28.0
			84/03/04	1550	Flood	11	22.0
			84/03/05	1020	Ebb	<2	18.0
			84/03/05	1515	Flood	<2	23.5
			84/03/06	1040	Ebb	<2	23.0
NH017	49 15.48	124 10.64	83/05/31	0925	Ebb	5	26.0
			83/06/01	0915	High Slack	<2	26.5
			83/06/02	1615	Low Slack	2	25.0
			83/06/03	1430	Ebb	<2	25.0
			83/06/04	1445	Ebb	<2	25.5
			83/06/05	1445	High Slack	<2	24.0
			83/06/06	1505	High Slack	<2	25.5
			83/06/07	1500	Flood	<2	26.0
			83/06/08	1425	Flood	<2	20.0
			84/02/28	1045	Low Slack	5	20.0
			84/02/29	0910	Ebb	8	25.0
			84/03/02	0910	Ebb	<2	25.0
			84/03/03	0900	Ebb	<2	25.5
			84/03/03	1505	Flood	<2	22.5
			84/03/04	1545	Flood	<2	25.0
			84/03/05	1025	Ebb	<2	25.0
			84/03/06	1045	Ebb	13	25.0
NH018	49 15.28	124 10.15	83/05/31	0925	Ebb	<2	25.0
			83/06/01	0915	High Slack	<2	27.0
			83/06/02	1615	Low Slack	<2	25.0
			83/06/03	1430	Ebb	<2	25.0
			83/06/04	1445	Ebb	<2	26.0

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TABLE 2 : Daily Data Record for Marine Sample Stations
(Area 17)

Station	Latitude	Longitude	Date	Time	Tide	Fec.Colif.	Salinity
NH018	continued...		83/06/05	1445	High Slack	<2	24.0
			83/06/06	1505	High Slack	<2	25.5
			83/06/07	1550	High Slack	<2	26.0
			83/06/08	1425	Flood	<2	20.0
			84/02/28	1040	Low Slack	7	20.0
			84/02/29	0915	Ebb	5	26.5
			84/03/02	0910	Ebb	2	26.5
			84/03/03	0900	Ebb	<2	24.5
			84/03/03	1505	Flood	<2	22.0
			84/03/04	0825	Ebb	<2	26.0
			84/03/04	1545	Flood	<2	24.0
			84/03/05	1030	Ebb	<2	23.5
			84/03/06	1045	Ebb	<2	25.5
NH019	49 15.24	124 09.80	83/05/31	0930	Ebb	<2	25.0
			83/06/01	0920	High Slack	2	27.0
			83/06/02	1610	Low Slack	<2	25.0
			83/06/03	1430	Ebb	2	24.5
			83/06/04	1440	Ebb	2	25.5
			83/06/05	1440	High Slack	2	26.0
			83/06/06	1500	High Slack	<2	25.0
			83/06/07	1550	High Slack	<2	26.0
			83/06/08	1425	Flood	4	20.0
			84/02/28	1040	Low Slack	<2	26.0
			84/02/29	0915	Ebb	<2	26.5
			84/03/02	0915	Ebb	<2	26.5
			84/03/03	0905	Ebb	2	25.5
			84/03/03	1500	Flood	<2	24.5
			84/03/04	0820	Ebb	6	25.0
			84/03/04	1545	Flood	<2	24.0
			84/03/05	1030	Ebb	<2	15.0
			84/03/06	1050	Ebb	<2	25.5
NH020	49 15.28	124 09.41	83/05/31	0930	Ebb	13	25.0
			83/06/01	0920	High Slack	2	27.5
			83/06/02	1610	Low Slack	<2	25.0
			83/06/03	1425	Ebb	<2	25.0
			83/06/04	1440	Ebb	<2	26.0
			83/06/05	1440	High Slack	<2	26.0
			83/06/06	1500	High Slack	4	25.0
			83/06/07	1455	Flood	2	26.0
			83/06/08	1420	Flood	2	19.5
			84/02/28	1035	Low Slack	<2	28.0
			84/02/29	0920	Ebb	5	28.0
			84/03/02	0920	Ebb	<2	28.0
			84/03/03	0910	Ebb	8	22.0
			84/03/03	1500	Flood	<2	25.0

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TABLE 2 : Daily Data Record for Marine Sample Stations
(Area 17)

Station	Latitude	Longitude	Date	Time	Tide	Fec.Colif.	Salinity
NH020	continued...		84/03/04	0820	Ebb	<2	24.5
			84/03/04	1540	Flood	<2	26.0
			84/03/05	1030	Ebb	<2	24.5
			84/03/06	1050	Ebb	<2	25.5
NH023	49 15.62	124 07.48	83/05/31	0945	Ebb	<2	25.0
			83/06/01	0930	High Slack	<2	26.0
			83/06/02	1605	Low Slack	<2	25.0
			83/06/03	1420	Ebb	<2	25.0
			83/06/04	1430	Ebb	<2	26.0
			83/06/05	1430	High Slack	<2	26.0
			83/06/05	1440	Flood	<2	26.0
			83/06/07	1450	Flood	<2	23.0
			83/06/08	1415	Flood	<2	20.0
			84/02/28	1010	Low Slack	<2	28.0
			84/02/29	0930	Ebb	<2	28.0
			84/03/02	0925	Ebb	<2	28.0
			84/03/03	0915	Ebb	<2	25.5
			84/03/04	0915	Ebb	<2	25.0
			84/03/05	1035	Ebb	<2	26.5
			84/03/06	1055	Ebb	23	26.5
NH025	49 15.39	124 06.60	83/05/31	0955	Ebb	<2	26.0
			83/06/01	0935	Ebb	<2	26.0
			83/06/02	1605	Low Slack	<2	24.5
			83/06/03	1415	Ebb	2	24.5
			83/06/04	1430	Ebb	<2	26.0
			83/06/05	1430	High Slack	2	26.0
			83/06/06	1450	Flood	33	25.0
			83/06/07	1450	Flood	<2	23.0
			83/06/08	1415	Flood	2	20.0
			84/02/28	1015	Low Slack	2	28.0
			84/02/29	0935	Ebb	5	26.0
			84/03/02	0925	Ebb	2	26.0
			84/03/03	0915	Ebb	<2	22.0
			84/03/04	0915	Ebb	5	25.0
			84/03/05	1035	Ebb	<2	24.5
			84/03/06	1100	Ebb	<2	26.0
NH028	49 15.48	124 05.00	83/05/31	1020	Ebb	17	26.0
			83/06/01	0950	Ebb	11	26.0
			83/06/04	1425	Ebb	2	25.5
			83/06/05	1425	High Slack	<2	28.0
			83/06/06	1400	Flood	<2	25.0
			83/06/07	1400	Flood	<2	22.0
			83/06/08	1350	Flood	14	24.0
			84/02/29	0945	Ebb	2	

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TABLE 2 : Daily Data Record for Marine Sample Stations
(Area 17)

Station	Latitude	Longitude	Date	Time	Tide	Fec.Colif.	Salinity
NH028	continued...		84/03/02	0935	Ebb	<2	25.0
			84/03/03	0920	Ebb	<2	26.5
			84/03/04	0920	Ebb	7	26.0
			84/03/05	1040	Ebb	<2	28.0
			84/03/06	1100	Ebb	4	26.0
NH032	49 15.37	124 04.77	83/05/31	1020	Ebb	<2	27.0
			83/06/01	0955	Ebb	5	26.0
			83/06/04	1420	Ebb	5	26.0
			83/06/05	1425	High Slack	8	26.0
			83/06/06	1410	Flood	13	25.0
			83/06/07	1440	Flood	<2	22.0
			83/06/08	1355	Flood	5	20.0
			84/02/29	0950	Ebb	2	29.5
			84/03/02	0935	Ebb	2	29.5
			84/03/03	0925	Ebb	<2	25.0
			84/03/04	0920	Ebb	2	27.0
			84/03/05	1045	Ebb	2	27.5
			84/03/06	1100	Ebb	<2	26.5
NH036	49 15.29	124 04.53	83/05/31	1025	Ebb	2	27.0
			83/06/01	1000	Ebb	5	26.0
			83/06/04	1420	Ebb	2	26.0
			83/06/05	1420	High Slack	5	26.0
			83/06/06	1415	Flood	8	25.0
			83/06/07	1435	Flood	<2	22.0
			83/06/08	1435	Flood	<2	21.5
			84/02/29	0955	Ebb	<2	28.0
			84/03/02	0940	Ebb	5	28.0
			84/03/03	0925	Ebb	4	25.0
			84/03/04	0925	Ebb	5	28.0
			84/03/05	1045	Ebb	<2	26.0
			84/03/06	1105	Ebb	<2	27.0
NH041	49 15.13	124 04.13	83/05/31	1030	Ebb	<2	27.0
			83/06/01	1000	Ebb	<2	21.0
			83/06/04	1415	Ebb	8	25.5
			83/06/05	1420	High Slack	<2	26.0
			83/06/06	1425	Flood	2	25.0
			83/06/07	1430	Flood	<2	20.0
			83/06/08	1400	Flood	2	22.0
			84/02/29	1000	Low Slack	8	28.5
			84/03/02	0940	Ebb	<2	28.5
			84/03/03	0930	Ebb	<2	26.0
			84/03/04	0925	Ebb	5	28.0
			84/03/05	1050	Ebb	<2	27.5
			84/03/06	1105	Ebb	<2	26.5

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TABLE 2 : Daily Data Record for Marine Sample Stations
(Area 17)

Station	Latitude	Longitude	Date	Time	Tide	Fec.Colif.	Salinity
NH045	49 15.14	124 03.74	83/05/31	1035	Ebb	2	26.0
			83/06/01	1005	Ebb	49	25.0
			83/06/04	1410	Ebb	<2	26.0
			83/06/05	1415	High Slack	<2	26.5
			83/06/06	1420	Flood	49	26.0
			83/06/07	1430	Flood	8	20.0
			83/06/08	1400	Flood	<2	22.0
			84/02/29	1000	Low Slack	7	28.0
			84/03/02	0945	Ebb	<2	28.0
			84/03/03	0930	Ebb	<2	25.5
			84/03/04	0930	Ebb	<2	28.0
			84/03/05	1050	Ebb	2	24.0
			84/03/06	1110	Ebb	<2	26.0
NH047	49 15.08	124 03.53	83/05/31	1035	High Slack	4	26.0
			83/06/01	1005	High Slack	<2	25.0
			83/06/04	1410	Ebb	<2	25.5
			83/06/05	1415	High Slack	<2	26.5
			83/06/06	1415	Flood	<2	26.0
			83/06/07	1430	Flood	<2	20.0
			83/06/08	1430	Flood	<2	22.0
			84/02/29	1005	Low Slack	<2	28.0
			84/03/02	0945	Ebb	<2	28.0
			84/03/03	0935	Ebb	<2	26.0
			84/03/04	0935	Ebb	<2	28.0
			84/03/05	1055	Ebb	<2	26.5
			84/03/06	1110	Ebb	2	24.0
NH052	49 16.32	124 06.85	83/05/31	1005	Ebb	<2	28.0
			83/06/01	0940	Ebb	2	26.0
			83/06/02	1600	Low Slack	<2	26.0
			83/06/03	1410	Ebb	<2	25.0
			83/06/04	1350	Ebb	<2	26.0
			83/06/05	1345	High Slack	<2	26.5
			83/06/06	1405	Flood	<2	26.0
			83/06/07	1400	Flood	<2	20.5
			83/06/08	1340	Flood	<2	20.0
			84/02/29	1015	Low Slack	2	28.0
			84/03/02	0955	Ebb	<2	28.0
			84/03/03	0940	Ebb	<2	27.5
			84/03/04	0940	Ebb	<2	28.0
			84/03/05	1100	Ebb	5	26.0
			84/03/06	1120	Ebb	<2	27.5
NH053	49 16.23	124 09.90	83/05/31	0915	Ebb	2	27.0
			83/06/01	0910	High Slack	<2	28.0
			83/06/02	1635	Low Slack	<2	26.5
			83/06/03	1450	Ebb	<2	25.0

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TABLE 2 : Daily Data Record for Marine Sample Stations
(Area 17)

Station	Latitude	Longitude	Date	Time	Tide	Fec.Colif.	Salinity	
NH053	continued...		83/06/04	1505	Ebb	<2	26.0	
			83/06/05	1505	High Slack	<2	26.0	
			83/06/06	1525	High Slack	<2	25.0	
			83/06/07	1520	Flood	<2	28.0	
			83/06/08	1445	Flood	5	20.0	
			84/02/28	1110	Low Slack	2	24.0	
			84/02/29	0845	Ebb	2	26.5	
			84/03/02	0905	Ebb	<2	26.5	
			84/03/02	0905	Ebb	<2	28.5	*
			84/03/03	0855	Ebb	<2	27.5	
			84/03/03	0855	Ebb	<2	28.0	*
			84/03/03	1540	Flood	<2	28.0	
			84/03/03	1540	Flood	<2	28.0	*
			84/03/04	0900	Ebb	<2	28.0	*
			84/03/04	0930	Ebb	<2	28.0	
			84/03/04	1605	Flood	<2	28.0	
			84/03/04	1610	Flood	<2	28.0	*
			84/03/05	1000	Ebb	<2	27.0	
			84/03/06	1020	Ebb	<2	27.5	
NH054	.	.	84/03/05	1005	Ebb	<2	27.5	
			84/03/06	1025	Ebb	<2	24.5	

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TABLE 3 : Daily Data Record for Marine Sample Stations
(Area 17)

Station	Latitude	Longitude	Date	Time	Tide	Fec.Colif.	Salinity
PL059	49 13.63	123 57.07	83/06/02	0925	High Slack	79	26.0
			83/06/03	0920	Flood	17	25.0
			83/06/04	0930	High Slack	2	25.0
			83/06/05	1230	High Slack	5	25.5
			83/06/07	0850	Ebb	5	25.5
			83/06/09	0645	Ebb	430	23.5
			84/02/28	1150	Low Slack	79	29.0
			84/02/29	0825	Ebb	23	29.0
			84/03/01	0830	Ebb	13	28.0
			84/03/02	0905	Ebb	2	28.0
			84/03/05	0840	High Slack	2	28.0
PL060	49 13.52	123 56.97	83/06/02	0925	High Slack	79	25.0
			83/06/03	0915	Flood	23	25.0
			83/06/04	0900	High Slack	11	25.0
			83/06/05	1220	High Slack	2	26.0
			83/06/09	0640	Ebb	540	23.0
			84/02/28	1240	Low Slack	33	27.0
			84/02/29	0900	Ebb	49	30.0
			84/03/01	0905	Ebb	5	27.5
			84/03/02	0900	Ebb	<2	26.5
			84/03/05	0830	High Slack	<2	28.0
PL062	49 13.43	123 56.84	83/06/02	0920	High Slack	43	26.0
			83/06/03	0910	Flood	2	25.0
			83/06/05	1230	High Slack	2	26.0
			83/06/09	0635	Ebb	110	24.0
			84/02/28	1245	Low Slack	13	27.0
			84/02/29	0855	Ebb	14	25.0
			84/03/01	0900	Ebb	49	23.0
			84/03/02	0900	Ebb	2	27.0
			84/03/05	0830	High Slack	8	28.0
PL064	49 13.77	123 57.29	83/06/09	0720	Ebb	5	26.0
			84/02/28	1205	Flood	79	29.0
			84/02/29	0845	Ebb	4	28.0
			84/03/01	0840	Ebb	49	28.5
			84/03/02	0915	Ebb	<2	27.5
			84/03/05	0850	Ebb	2	26.5
PL065	49 13.65	123 56.82	83/06/09	0700	Ebb	5	24.0
			84/02/28	1210	Flood	7	29.0
			84/02/29	0830	Ebb	2	28.0
			84/03/01	0835	Ebb	5	28.5
			84/03/02	0905	Ebb	<2	28.0
			84/03/05	0835	Ebb	<2	28.0
PL066	49 13.72	123 57.10	83/06/09	0720	Ebb	4	24.0

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TABLE 3 : Daily Data Record for Marine Sample Stations
(Area 17)

Station	Latitude	Longitude	Date	Time	Tide	Fec.Colif.	Salinity
PL066	continued...		84/02/28	1205	Flood	46	29.0
			84/02/29	0835	Ebb	5	28.0
			84/03/01	0850	Ebb	8	26.5
			84/03/02	0910	Ebb	<2	28.0
PL067	49 13.61	123 57.20	83/06/09	0715	Ebb	17	24.0
			84/02/28	1200	Flood	33	29.0
			84/02/29	0840	Ebb	11	26.0
			84/03/01	0835	Ebb	14	27.0
			84/03/02	0910	Ebb	<2	27.5
			84/03/05	0345	Ebb	<2	27.5
PL068	49 13.84	123 57.40	83/06/09	0715	Ebb	23	23.0
			84/02/28	1205	Flood	31	28.0
			84/02/29	0840	Ebb	8	29.0
			84/03/01	0840	Ebb	17	28.5
			84/03/02	0915	Ebb	<2	26.0
			84/03/05	0850	Ebb	2	28.0

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TABLE 4 : Daily Data Record for Marine Sample Stations
(Area 16)

Station	Latitude	Longitude	Date	Time	Tide	Fec.Colif.	Salinity
LI001	49 28.88	124 21.30	83/06/02	1135	Ebb	11	26.0
			83/06/03	1220	Ebb	5	25.5
			83/06/04	1205	High Slack	<2	26.5
			83/06/05	1125	Flood	2	26.5
			83/06/06	1200	Flood	5	26.0
			83/06/07	1150	Flood	5	25.0
			83/06/08	1130	Low Slack	7	26.5
			84/03/01	1050	Low Slack	4	24.0
			84/03/03	0955	Ebb	<2	28.0
			84/03/04	0945	Ebb	<2	27.5
			84/03/05	0930	Ebb	<2	28.5
			84/03/06	1010	Ebb	<2	26.5
LI002	49 28.92	124 20.00	83/06/02	1140	Ebb	2	26.0
			83/06/03	1215	Ebb	<2	25.0
			83/06/04	1205	High Slack	<2	26.5
			83/06/05	1120	Flood	<2	26.0
			83/06/06	1200	Flood	<2	26.0
			83/06/07	1150	Flood	<2	25.0
			83/06/08	1130	Low Slack	13	26.5
			84/03/01	1050	Low Slack	<2	25.5
			84/03/03	0955	Ebb	2	28.5
			84/03/04	0945	Ebb	<2	27.5
			84/03/05	0930	Ebb	<2	28.0
			84/03/06	1010	Ebb	<2	28.0
LI003	49 29.00	124 20.98	83/06/02	1145	Ebb	4	26.0
			83/06/03	1215	Ebb	<2	25.0
			83/06/04	1200	High Slack	<2	26.5
			83/06/05	1120	Flood	5	26.5
			83/06/06	1200	Flood	2	26.0
			83/06/07	1150	Flood	<2	25.5
			83/06/08	1125	Low Slack	2	26.5
			84/03/01	1045	Low Slack	11	27.5
			84/03/03	0950	Ebb	<2	28.5
			84/03/04	0925	Ebb	2	28.0
			84/03/05	0925	Ebb	<2	27.0
			84/03/06	1005	Ebb	2	27.0
LI004	49 29.18	124 21.40	83/06/02	1150	Ebb	<2	26.0
			83/06/03	1205	Ebb	<2	25.0
			83/06/04	1200	High Slack	<2	26.5
			83/06/05	1115	Flood	<2	26.5
			83/06/06	1150	Flood	2	26.0
			83/06/07	1155	Flood	<2	26.0
			83/06/08	1120	Low Slack	<2	26.0
			84/03/01	1035	Low Slack	17	28.0
			84/03/03	0940	Ebb	<2	28.0

APPENDIX I
TABLE 4 : Daily Data Record for Marine Sample Stations
(Area 16)

Station	Latitude	Longitude	Date	Time	Tide	Fec.Colif.	Salinity
LI004	continued...		84/03/04	0920	Ebb	<2	28.0
			84/03/05	0925	Ebb	<2	29.0
			84/03/06	1000	Ebb	<2	27.5
LI005	49 29.50	124 20.70	83/06/02	1200	Ebb	4	25.0
			83/06/04	1155	High Slack	8	26.5
			83/06/05	1110	Flood	2	26.5
			83/06/06	1150	Flood	2	26.5
			83/06/07	1140	Flood	9	26.0
			83/06/08	1115	Low Slack	<2	25.0
			84/03/01	1105	Low Slack	4	28.0
			84/03/03	1025	Ebb	<2	28.0
			84/03/04	1010	Ebb	2	28.0
			84/03/05	0840	Ebb	2	28.5
			84/03/06	1025	Ebb	<2	27.5
LI006	49 28.80	124 21.80	83/06/02	1215	Ebb	<2	24.5
			83/06/03	1205	Ebb	<2	25.0
			83/06/04	1215	High Slack	2	26.0
			83/06/05	1135	Flood	<2	26.0
			83/06/06	1310	Flood	<2	26.0
			83/06/07	1130	Flood	<2	26.0
			83/06/08	1145	Flood	<2	22.0
			84/03/01	1030	Low Slack	2	28.0
			84/03/03	0935	Ebb	<2	28.0
			84/03/04	0915	Ebb	<2	28.0
			84/03/05	0915	Ebb	<2	28.0
			84/03/06	0955	Ebb	2	27.0
LI007	49 29.95	124 21.32	83/06/02	1225	Ebb	11	25.5
			83/06/04	1145	High Slack	2	26.5
			83/06/05	1100	Flood	<2	26.5
			83/06/06	1130	Flood	2	26.0
			83/06/07	1130	Flood	<2	26.0
			83/06/08	1110	Low Slack	2	26.0
			84/03/01	1120	Low Slack	23	24.0
			84/03/03	1035	Ebb	<2	25.5
			84/03/04	1020	Ebb	<2	27.5
			84/03/05	1000	Ebb	2	26.0
			84/03/06	1030	Ebb	<2	26.0
LI008	49 28.88	124 21.10	83/06/02	1230	Ebb	2	26.0
			83/06/04	1150	High Slack	2	26.5
			83/06/05	1100	Flood	<2	26.0
			83/06/06	1140	Flood	2	26.0
			83/06/07	1135	Flood	2	26.0
			83/06/08	1110	Low Slack	<2	26.5

APPENDIX I
TABLE 4 : Daily Data Record for Marine Sample Stations
(Area 16)

Station	Latitude	Longitude	Date	Time	Tide	Fec.Colif.	Salinity
LI008	continued...		84/03/01	1115	Low Slack	<2	28.0
			84/03/03	1030	Ebb	<2	28.0
			84/03/04	1015	Ebb	<2	28.0
			84/03/05	0950	Ebb	<2	26.0
			84/03/06	1035	Ebb	2	25.5
LI009	49 31.20	124 20.50	83/06/02	1345	Ebb	<2	26.5
			83/06/03	1140	High Slack	<2	25.0
			83/06/04	1125	High Slack	2	26.5
			83/06/05	1045	Flood	<2	26.0
			83/06/06	1110	Flood	<2	27.0
			83/06/07	1105	Flood	<2	28.0
			83/06/08	1050	Low Slack	<2	26.5
			84/03/01	1150	Low Slack	<2	27.0
			84/03/03	1055	Ebb	<2	28.0
			84/03/04	1050	Ebb	<2	28.0
			84/03/05	1025	Ebb	<2	28.0
			84/03/06	1055	Ebb	<2	26.5
LI010	49 31.20	124 20.75	83/06/02	1350	Ebb	<2	26.0
			83/06/03	1140	High Slack	<2	25.0
			83/06/04	1125	High Slack	2	26.0
			83/06/05	1045	Flood	<2	26.0
			83/06/06	1110	Flood	<2	26.0
			83/06/07	1110	Flood	<2	28.0
			83/06/08	1055	Low Slack	<2	26.0
			84/03/01	1155	Low Slack	<2	27.0
			84/03/03	1100	Ebb	<2	28.5
			84/03/04	1050	Ebb	<2	28.0
			84/03/05	1025	Ebb	<2	28.0
			84/03/06	1100	Ebb	<2	27.5
LI011	49 29.80	123 15.45	83/06/02	1420	Ebb	11	25.5
			83/06/03	1110	High Slack	8	25.0
			83/06/04	1105	High Slack	17	26.0
			83/06/05	1030	Flood	11	25.0
			83/06/06	1010	Low Slack	2	26.0
			83/06/07	1040	Low Slack	130	26.0
			83/06/08	1035	Low Slack	14	26.0
			84/03/01	1310	Flood	<2	25.5
			84/03/03	1150	Low Slack	2	26.5
			84/03/04	1125	Ebb	<2	27.5
			84/03/05	1120	Ebb	<2	27.0
LI012	49 29.90	124 14.95	83/06/02	1425	Ebb	<2	26.0
			83/06/03	1100	High Slack	2	25.5
			83/06/04	1055	High Slack	5	26.0

APPENDIX I
TABLE 4 : Daily Data Record for Marine Sample Stations
(Area 16)

Station	Latitude	Longitude	Date	Time	Tide	Fec.Colif.	Salinity
LI012	continued...		83/06/05	1015	Flood	2	25.5
			83/06/06	1005	Low Slack	<2	26.0
			83/06/07	1035	Low Slack	<2	25.5
			83/06/08	1035	Low Slack	<2	26.0
			84/03/01	1320	Flood	<2	28.0
			84/03/03	1155	Low Slack	<2	28.0
			84/03/04	1125	Ebb	<2	28.0
			84/03/05	1120	Ebb	<2	27.0
LI013	49 30.00	124 14.03	83/06/02	1430	Ebb	2	26.0
			83/06/03	1055	High Slack	<2	25.0
			83/06/04	1045	High Slack	<2	25.5
			83/06/05	1015	Flood	<2	25.5
			83/06/06	1000	Low Slack	<2	26.0
			83/06/07	1030	Low Slack	<2	25.5
			83/06/08	1030	Low Slack	<2	22.0
			84/03/01	1330	Flood	<2	28.5
			84/03/03	1215	Low Slack	<2	28.5
			84/03/04	1135	Ebb	<2	28.5
			84/03/05	1130	Ebb	<2	28.0
LI014	49 29.85	124 13.80	83/06/02	1510	Ebb	<2	25.5
			83/06/03	1050	High Slack	<2	25.0
			83/06/04	1000	High Slack	<2	26.0
			83/06/05	1015	Flood	<2	25.0
			83/06/06	1000	Low Slack	<2	26.0
			83/06/07	1020	Low Slack	<2	25.0
			83/06/08	1025	Low Slack	<2	22.0
			84/03/01	1355	Flood	<2	28.5
			84/03/03	1220	Low Slack	<2	27.5
			84/03/04	1135	Ebb	<2	28.0
			84/03/05	1130	Ebb	<2	28.0
LI015	49 29.90	124 23.40	83/06/02	1515	Ebb	<2	25.0
			83/06/03	1045	High Slack	<2	24.0
			83/06/04	1000	High Slack	<2	25.5
			83/06/05	1010	Flood	<2	25.5
			83/06/06	0950	Low Slack	<2	25.0
			83/06/07	1015	Low Slack	<2	26.0
			83/06/08	1025	Low Slack	<2	22.0
			84/03/01	1400	Flood	<2	29.0
			84/03/03	1225	Low Slack	<2	28.0
			84/03/04	1140	Ebb	<2	28.5
			84/03/05	1135	Ebb	<2	28.0
LI016	49 30.80	124 17.65	83/06/03	1130	Ebb	2	24.0
			83/06/04	1120	High Slack	<2	26.0

APPENDIX I
TABLE 4: Daily Data Record for Marine Sample Stations
(Area 16)

Station	Latitude	Longitude	Date	Time	Tide	Fec.Colif.	Salinity
LI016	continued...		83/06/05	1040	Flood	2	26.0
			83/06/06	1025	Flood	5	26.0
			83/06/07	1050	Low Slack	17	26.0
			83/06/08	1045	Low Slack	<2	26.0
			84/03/01	1250	Flood	<2	28.0
			84/03/03	1140	Low Slack	<2	27.0
			84/03/04	1110	Ebb	<2	27.0
			84/03/05	1100	Ebb	<2	27.5
LI017	49 30.75	124 17.40	83/06/03	1120	Ebb	<2	24.0
			83/06/04	1115	High Slack	<2	25.5
			83/06/05	1035	Flood	2	26.0
			83/06/06	1020	Low Slack	7	26.0
			83/06/07	1050	Low Slack	2	26.0
			83/06/08	1045	Low Slack	2	24.0
			84/03/01	1255	Flood	<2	28.0
			84/03/03	1145	Low Slack	<2	28.0
			84/03/04	1115	Ebb	220	28.0
			84/03/05	1055	Ebb	540	28.5
LI018	00 00.00	000 00.00	84/03/01	1200	Low Slack	8	25.5
			84/03/03	1110	Low Slack	<2	28.0
			84/03/04	1100	Ebb	2	28.5
			84/03/05	1030	Ebb	8	26.0
			84/03/06	1205	Ebb	<2	27.5

APPENDIX II

FRESHWATER SAMPLE STATION LOCATION DESCRIPTIONS

APPENDIX II

TABLE 1 SHELLFISH SURVEY - JUNE 1983, FEB. 1984
FRESHWATER STATION DESCRIPTIONS
- Nanoose Harbour and Lantzville

STATION	DESCRIPTION
S1	Nanoose Creek at the bridge on Powder Point Road
S2	North drainage ditch on the Rosen Farm
S3	South drainage ditch on the Rosen Farm
S4	Total drainage on the Rosen Farm
S5	Bonnell Creek at the highway
S6	Mill Creek at the highway
S7	Unnamed Creek at the mouth below the butcher shop
S8	S7 at the highway opposite the butcher shop
S9	Knarston Creek at the mouth
S10	Knarston Creek at the end of Stone Road
S11	Knarston Creek 75 yards upstream of the mouth
S12	Stewart Creek at Blunder Point
S13	Bloods Creek at the mouth
S14	Bloods Creek at Aulds Road and Green Lake Crescent
S15	Bloods Creek upstream S13
S16	Bloods Creek upstream S15
S17	Bloods Creek upstream S16 above Auger Road
S18	Unnamed Creek in a small cove west of the Gary Oaks Subdivision
S19	S18 at the highway to Schooner Cove
S20	Creek at CFMETR
S21	Storm runoff at base of the main road through Gary Oaks
S22	Creek N.W. of the main lease at the head of the harbour
S23	Creek at Jacks and McGill Road - Lantzville
S24	Runoff at the foot of Lavender Road - Lantzville
S25	Runoff at the foot of Huddlestone Road - Lantzville
S26	Culvert east of the foot of Tweedhope Road - Lantzville
S27	Creek at highway and F.A. Whitehouse Mailbox - Lantzville
S28	West of rock breakwater on the Indian Reserve
S29	At the Island highway across from Hillview Road
S30	At public access south of the Pentecostal Church Camp
S31	500 yards down the railway track from S31
S32	On the Island highway west of S29
S33	Rosen drainage at inter-tidal zone of the harbour
S34	Nanoose Creek at the mouth
S35	Bonnell Creek at the mouth
S36	Combined flows of Bonnell and Nanoose

APPENDIX II

TABLE 2 SHELLFISH SURVEY - JUNE 1983, FEB. 1984
FRESHWATER STATION DESCRIPTIONS
- Deep Bay

STATION	DESCRIPTION
S1	Salmon Creek at Chrome Point Road and Finlay Residences
S2	Seepage 20 m west of the store
S3	Seepage 10 m west of the store
S4	Creek 250 m west of the store
S5	S1 at the mouth

APPENDIX II

TABLE 3 SHELLFISH SURVEY - JUNE 1983, FEB. 1984
FRESHWATER STATION DESCRIPTIONS
- Lasqueti Island

STATION	DESCRIPTION
S1	At the shipyards - Scottie Bay
S2	Hadley Creek at the highway
S3	Head of the bay opposite marine station 16
S4	Head of the cove in Tucker Bay
S5	Head of the cove opposite marine station 3
S6	Mouth of Hadley Creek

APPENDIX II

TABLE 4 SHELLFISH SURVEY - JUNE 1983, FEB. 1984
FRESHWATER STATION DESCRIPTIONS
- Pipers Lagoon

STATION	DESCRIPTION
S1	In line with Pipers Lagoon pump station on Lagoon Road

APPENDIX III

DAILY BACTERIOLOGICAL RESULTS FOR FRESHWATER SAMPLE STATIONS

APPENDIX III

TABLE 1 DAILY BACTERIOLOGICAL MF DATA FOR FRESHWATER AND EFFLUENT SAMPLE STATIONS - NANOOSE/LANTZVILLE

SAMPLE STATION	COLLECTION DATE	COUNT/100 mL F.C.	COUNT/100 mL F.S.	FC:FS
S1	83 06 03	66	28	
	83 06 04	28	25	
	83 06 05	23	33	
	83 06 06	23	37	
	83 06 07	25	20	
	83 06 08	187	138	1.36
	84 02 28	< 10	< 10	
	84 02 29	2	1	
	84 03 01	6		
	84 03 03	1		
S2	83 06 01	220	110	2.0
	83 06 05	430	70	6.14
	83 06 06	340	220	1.55
S3	83 06 01	< 10	50	
S4	83 06 03	510	100	5.1
	83 06 04	490	90	5.44
	83 06 05	120	80	1.5
	83 06 06	210	17	12.35
	83 06 07	230	60	3.83
	84 02 28	10	80	
	84 02 29	19		
S5	83 06 01	< 10	< 10	
	83 06 03	18	9	
	83 06 04	7	0	
	83 06 05	10	1	
	83 06 06	49	6	
	83 06 07	22	0	
S5	83 06 08	36	14	
	84 02 23	< 10	< 10	
	84 02 29	4		
	84 03 01	7		
	84 03 03	0		
S6	83 06 01	< 10	< 10	
	83 06 03	0	1	
	83 06 04	0	0	
	83 06 05	0	5	
	83 06 06	0	3	
	83 06 07	0	0	
	84 02 28	0	< 10	
	84 02 29	3		
	84 03 01	8		
S7	83 06 01	20	130	0.15
S8	83 06 01	10	140	0.07
S9	83 06 01	240	400	0.6
	83 06 03	40	60	
	83 06 04	90	37	
	83 06 05	56	100	0.56
	83 06 06	109	128	0.85
	83 06 07	80	60	
	83 06 08	80	70	
	84 02 28	10	< 10	
	84 02 29	3		
	84 03 03	8		

Continued...

APPENDIX III

TABLE 1 DAILY BACTERIOLOGICAL MF DATA FOR FRESHWATER AND EFFLUENT SAMPLE STATIONS - NANOOSE/LANTZVILLE (Continued)

SAMPLE STATION	COLLECTION DATE	COUNT/100 mL F.C.	COUNT/100 mL F.S.	FC:FS
S10	83 06 08	40	50	
S11	83 06 06	189	396	0.48
	83 06 07	72	116	0.62
S12	83 06 01	170	330	0.52
	83 06 03	210	200	1.05
	83 06 04	140	30	4.67
	83 06 05	1410	890	1.58
	83 06 06	110	180	0.61
	83 06 07	210	160	1.31
	83 06 08	60	50	
	84 02 28	100	130	0.77
	84 02 29	113		
	84 03 01	70		
S13	83 06 01	220	180	1.22
	83 06 03	810	210	3.86
	83 06 04	1450	120	12.08
	83 06 05	200	300	0.67
	83 06 06	310	230	1.35
	83 06 07	600	80	7.5
	83 06 08	870	150	5.8
	84 02 28	30	10	
	84 02 29	13		
	84 03 01	9		
S14	83 06 05	30	10	
S15	83 06 08	140	120	1.17
S16	83 06 08	30	110	0.27
S17	83 06 08	< 10	170	
S18	83 06 01	< 10	370	
	84 02 28	250	60	4.17
	84 02 29	340	< 10	
	84 03 01	40		
	84 03 04	40		
S19	84 02 28	300	130	2.31
	84 02 29	50	20	
	84 03 06	48		
S20	84 02 28	60	10	
	84 02 29	91		
	84 03 06	0		
S21	84 02 28	< 10	< 10	
	84 02 29	3		
	84 03 01	1		
S22	84 02 28	< 10	20	
	84 02 29	4		
	84 03 01	3		
S23	84 02 28	100	40	2.5
	84 02 29	60	10	
	84 03 01	< 10		
S24	84 02 28	50	120	0.42
	84 02 29	111		
	84 03 03	< 10		

Continued...

APPENDIX III

TABLE 1 DAILY BACTERIOLOGICAL MF DATA FOR FRESHWATER AND EFFLUENT SAMPLE STATIONS - NANOOSE/LANTZVILLE
(Continued)

SAMPLE STATION	COLLECTION DATE	COUNT/100 mL F.C.	COUNT/100 mL F.S.	FC:FS
S25	84 02 28	50	50	
	84 02 29	40		
	84 03 01	18		
S26	84 02 28	70	10	
	84 02 29	200	10	20.0
	84 03 01	2800		
S27	84 02 28	200	13800	0.01
	84 02 29	50	300	0.17
	84 03 01	153	80	1.9
S28	84 02 28	< 10	< 10	
	84 02 29	26		
S29	84 02 28	< 10	< 10	
	84 02 29	1		
	84 03 01	0		
S30	84 02 23	< 10	< 10	
	84 02 29	1		
	84 03 01	1		
S31	84 02 28	< 10	< 10	
	84 03 01	2		
S32	84 02 29	10	10	
	84 03 01	5		
S33	84 03 05	5		
S34	84 03 05	0		
S35	84 03 05	2		
S36	84 03 05	5		

APPENDIX III

TABLE 2 DAILY BACTERIOLOGICAL MF DATA FOR FRESHWATER AND EFFLUENT SAMPLE STATIONS

SAMPLE STATION	COLLECTION DATE	COUNT/100 mL F.C.	COUNT/100 mL F.S.	FC:FS
DEEP BAY				
S1	83 06 04	30	90	
	83 06 06	112	190	0.59
	83 06 07	21	193	0.11
	83 06 08	40	60	
	84 02 28	10	< 10	
	84 02 29	9		
	84 03 01	20		
	84 03 05	55		
S2	83 06 04	190	490	0.39
	83 06 06	10	110	0.09
	83 06 07	242	TNTC	
	83 06 08	40	330	0.12
	84 02 28	< 10	< 10	
	84 02 29	0		
	84 03 01	< 10		
	84 03 02	20		
S3	83 06 06	< 10	110	
	83 06 07	12	11	
	84 02 28	< 10	< 10	
	84 02 29	< 10		
	84 03 01	0		
	84 03 02	0		
S4	83 06 06	< 10	20	
	83 06 07	13	93	
	84 02 28	< 10	< 10	
	84 02 29	< 10		
	84 03 01	0		
	84 03 02	1		
	84 03 05	1		
S5	83 06 08	170	100	1.7
	84 02 28	< 10		
	84 02 29	40		
	84 03 01	26		
	84 03 03	3		
LASQUETI ISLAND				
S1	84 03 02	3	1	
	84 03 04			
S2	84 03 02	13	5	
S3	84 03 02	65	2	
S4	84 03 02	13	0	
S5	84 03 03	0	0	
	84 03 04	1		
S6	84 03 04	6		
PIPERS LAGOON				
S1	84 02 28	10	< 10	
	84 02 29	3		
	84 03 01	3		
	84 03 02	3		

APPENDIX IV

SUMMARY OF BACTERIOLOGICAL RESULTS FOR FRESHWATER SAMPLE STATIONS

APPENDIX IV SUMMARY OF BACTERIOLOGICAL RESULTS FOR FRESHWATER AND EFFLUENT SAMPLE STATIONS

SAMPLE STATION	FECAL COLIFORM/100 mL			FECAL STREPTOCOCCI/100 mL			FC:FS RATIO
	No. of Samples	Range	Mean	No. of Samples	Range	Mean	
NANOOSE/LANTZVILLE							
S1	10	1 - 187	37.1	8	1 - 138	36.5	
S2	3	220 - 430	256.6	3	70 - 220	133.3	1.92
S3	1	< 10		1	50		
S4	7	10 - 510	227.0	6	17 - 100	79.5	2.86
S5	11	0 - 49	15.7	8	0 - 14	6.3	
S6	9	0 - 10	3.4	7	0 - < 10	4.1	
S7	1	20		1	130		
S8	1	10		1	140		
S9	10	3 - 240	71.6	8	< 10 - 400	108.1	0.66
S10	1	40		1	50		
S11	2	72 - 189	130.5	2	116 - 396	256.0	0.51
S12	10	60 - 1410	259.4	8	30 - 890	246.3	1.05
S13	10	9 - 1450	451.2	8	10 - 300	160.0	2.82
S14	1	30		1	10		
S15	1	140		1	120		
S16	1	30		1	110		
S17	1	< 10		1	170		
S18	5	< 10 - 340	136.0	3	< 10 - 370	146.6	0.93
S19	3	48 - 300	132.6	2	20 - 130	75.0	1.77
S20	3	0 - 91	50.3	1	10		
S21	3	1 - < 10	4.6	1	10		
S22	3	3 - < 10	5.6	1	20		
S23	3	< 10 - 100	56.6	2	< 10 - 40	25.0	
S24	3	< 10 - 111	57.0	1	120		
S25	3	18 - 50	36.0	1	50		
S26	3	70 - 2800	1023.3	2	10	10	102.3
S27	3	50 - 200	134.3	3	300 - 13800	4726.6	0.03
S28	2	< 10 - 26	19	1	< 10		
S29	3	0 - < 10	3.8	1	< 10		
S30	3	1 - < 10	4	1	< 10		
S31	2	2 - < 10	6	1	< 10		

Continued...

APPENDIX IV SUMMARY OF BACTERIOLOGICAL RESULTS FOR FRESHWATER AND EFFLUENT SAMPLE STATIONS
(Continued)

SAMPLE STATION	FECAL COLIFORM/100 mL			FECAL STREPTOCOCCI/100 mL			FC:FS RATIO
	No. of Samples	Range	Mean	No. of Samples	Range	Mean	
NANOOSE/LANTZVILLE (continued)							
S32	2	5 - 10	7.5	1	10		
S33	1	5					
S34	1	0					
S35	1	2					
S36	1	5					
DEEP BAY							
S1	8	9 - 112	37.0	5	< 10 - 193	108.6	0.34
S2	8	0 - 242	65.3	5	< 10 - 490	204.0	0.32
S3	6	0 - 12	7.0	3	< 10 - 110	43.6	
S4	7	0 - 13	6.4	3	< 10 - 93	41.0	
S5	5	3 - 170	49.8	1	100		4.98
LASQUETI ISLAND							
S1	2	1 - 3	2	1	1		
S2	1	25		1	5		
S3	1	65		1	2		
S4	1	13		1	0		
S5	1	0		1	0		
S6	1	1					
PIPERS LAGOON							
S1	4	3 - 10	5.0	1	10		

APPENDIX V

SUMMARY OF RAINFALL DATA

APPENDIX V
TABLE 1 RAINFALL DATA (mm)

DATE	NANAIMO	TEXADA ISLAND
May 26, 1983	-	
27	-	station
28	-	not
29	-	reporting
30	1.2	
31	-	
June 1	2.4	
2	1.6	
3	-	
4	-	
5	-	
6	-	
7	-	
8	1.8	
9	6.4	
Feb. 22, 1984	6.8	1.4
23	31.1	12.8
24	1.2	0.8
25	-	-
26	32.0	8.2
27	4.4	2.0
28	6.6	1.5
29	4.2	2.3
Mar. 1	0.8	1.6
2	-	-
3	-	-
4	-	-
5	-	-
6	-	-
7	-	-

APPENDIX VI

ISOLATE BIOCHEMICAL SUMMARIES

1 INTRODUCTION

The accuracy of the MPN test procedure in recovering fecal coliforms (specifically Escherichia coli) from the marine environment is routinely tested as part of the microbiology laboratory quality control procedure.

During shellfish surveys, a minimum of 10% of all positive (growth + gas) A-1 media tubes are subjected to biochemical identification to confirm the presence of E. coli in the sample. Positive tubes generally are generally picked randomly unless anomolous results are observed at individual sample stations.

2 MATERIALS AND METHODS

Inocula from positive A-1 tubes are streaked on Levine's EMB agar to obtain isolated colonies. After 24 hours incubation on Levine's EMB, typical coliform colonies are picked for further biochemical identification. If no typical coliform colonies are present, atypical colonies are selected for biochemical screening.

All isolates are subjected to biochemical screening using the API20E system (Analytab Products, New York).

3 RESULTS AND DISCUSSION

The summer survey, May 31-June 9, 1983, isolates proved to be all Escherichia coli (Table 1).

The winter survey, February 27-March 7, 1984, isolates were 96 percent Exchericlia coli.

Shellstock isolates taken during the summer survey were all Escherichia coli.

APPENDIX VI

TABLE 1 MPN ISOLATE BIOCHEMICAL SUMMARY
- Nanoose Survey, May 31-June 9, 1983

STATION SAMPLED	NO. OF ISOLATES	NO. OF POSITIVE *E. coli*	PERCENT POSITIVE
NH8	16	16	100
NH13	5	5	100
NH15	6	6	100
NH25	6	6	100
NH45	13	13	100
PL59	8	8	100
PL60	8	8	100
LI11	18	18	100
LI16	5	5	100
DB3	6	6	100
LH44	16	16	100
LH45	14	14	100
TOTAL	121	121	100

APPENDIX VI

TABLE 2 MPN BIOCHEMICAL SUMMARY

Nanoose Survey February 27 - March 7, 1984

STATION SAMPLED	NO. OF ISOLATES	NO. OF POSITIVE *E. coli*	PERCENT POSITIVE
BS1	9	9	100
BS2	9	9	100
BS4	2	2	100
LI4	5	5	100
LI7	5	5	100
LI17	11	11	100
LI18	3	2	66
NH3	1	1	100
NH6	5	5	100
NH15	17	17	100
NH16	4	4	100
NH19	3	3	100
NH20	3	3	100
NH36	2	2	100
NH52	2	2	100
PL59	14	14	100
PL62	6	6	100
PL66	6	3	50
TOTAL	107	103	96

APPENDIX VI

TABLE 3 SHELLFISH ISOLATE BIOCHEMICAL SUMMARY
- Nanoose Survey, May 31-June 9, 1983

STATION SAMPLED	NO. OF ISOLATES	NO. OF POSITIVE *E. Coli*	PERCENT POSITIVE
DB1	3	3	100
PL60	12	12	100
TOTAL	15	15	100